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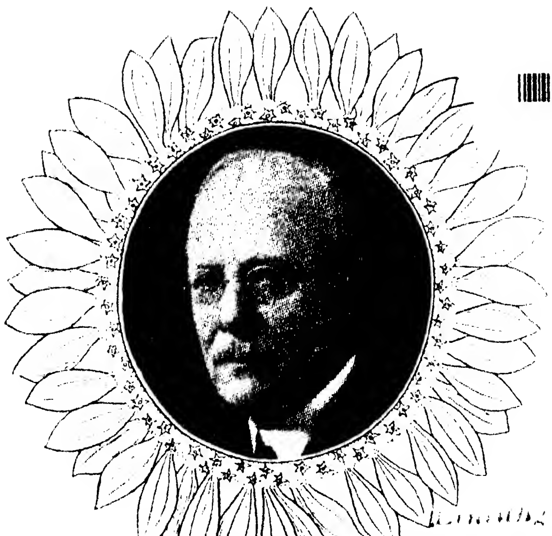

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AUTOSPASY AND REGENERATION IN THE ROACH, BLATTELLA GERMANICA (LINNAEUS).

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One of the more fortunate innate powers of living organisms is their ability to repair injured or lost tissues and parts. In an antagonistic and competitive world all living creatures are constantly beset, through injury and disease, with the problem of replacing the affected areas or succumbing to the results of the disaster. This restoration varies in extent from the healing of the slightest wound to some of the amazing examples of regeneration displayed by such animals as Planaria whose recuperative capacity virtually involves complete reproduction. In the last analysis all such repairs are merely phases of growth and differ physiologically only in extent.

With this viewpoint in mind, it is not surprising that cases of regeneration are encountered repeatedly in all living organisms, but it is only when these are of such extent that they involve the replacement of some integral part of the body that they attract particular attention. Nearly all plants have remarkable powers of regeneration as are indicated in their vegetative methods of reproduction. Thus, whole plants may develop from a detached leaf of Bryophyllum, from a portion of a potato tuber, or from a bit of the stem of a rose. Many a farmer has been astounded to find certain kinds of freshly set posts sprouting and growing into normal trees. While generally less developed among the animals, striking examples of this phenomenon are to be found in all of the principal phyla, being more highly developed where cell differentiation is slightest. Among the higher animals the process of regeneration is limited to such an extent that in man even minor wounds often leave scars.

In the Arthropoda powers of regeneration seem to be confined to the appendages, and wisely so, since these segmented structures, while serving the animals well in

*Contribution from the Department of Entomology, University of Kansas.

locomotion, feeding, sensation, and other activities, are for this very reason subject to injury and mutilation through contact with the environment. The literature dealing with the regrowth of appendages in the Crustacea alone is voluminous, but all of the major classes have been mentioned also and it is quite likely that regeneration occurs in most of the minor groups even though specific records are lacking. Few problems have produced as much theoretical speculation, especially in the publications of the marine biological stations where the chief animals of research have been decapod crustaceans.

Although regeneration is commonly acknowledged as being spread widely throughout the insect group, specific citations are surprisingly meager. Bourlet (1839), Lubbock (1873), and Morita (1926) have reported the regeneration of amputated appendages in the Thysanura and Collembola, chiefly in the antennae where growth initiates from the point of severance. Dragon-fly naiads have been found to reproduce legs by Watson (1891) for Agrion and by Bennazzi (1929) for Aescha. Lubbock (1864) observed that the terminal segments of the antennae in the young of Chloen (Ephemerida) were not reformed. In the Hemiptera, Gabler (1932) has noted the regeneration of antennal segments in five species. Numerous observations for the Orthoptera have been made, especially in the Phasmidae by Bordage (1897, 1898), Friedrich (1930), and Staudinger (1930) and in the Blattidae by Heineken (1829), Brindley (1897, 1898), and Illingworth (1916). The power of replacing lost legs among the Saltatorial Orthoptera is usually supposed to be absent, but Graber (1867) observed the reproduction of antennae in Gryllus and Locusta, so it is quite possible that the other appendages of these insects may have an equal ability. The ease with which the jumping legs of grasshoppers are lost may also be indicative of a subsequent renewal. For the Holometabola, the known records are for various lepidopterous larvae by Watson (1891), Newport (1844), and Kopec (1923).

Closely associated with regeneration in the Arthropoda will be found cases of autotomy or related phenomena. Whenever an animal possesses the ability to regenerate a lost or injured appendage, almost invariably such regrowth is merely a secondary manifestation of the previous activity of sloughing that member, either

reflexively or as a result of some extrinsic force. The term autotomy as proposed by Fredericq (1883) refers to the act of involuntary self-amputation, but its meaning has been loosely construed to include all losses of appendages from whatever cause, and even the subsequent regeneration. This is an unfortunate application but is due, at least in part, to the lack of a more general expression. Recognizing that some amputations, while occurring easily at predetermined loci of weakness, were not automatic, Pieron (1907) used the term autospasy to describe cases when an external pull must be applied to induce severance. Wood and Wood (1932) further clarified these terms by designating as autotilly the voluntary act of removing an injured appendage at points of weakness through the use of mouthparts or legs. These authors point out many bona fide instances of autotomy among the Crustacea, describing the mechanisms involved, and conclude that the range of these phenomena appears to have an evolutionary significance, since a graded series of forms showing autospasy, autotilly, and finally autotomy, conforms to the usual systematic arrangement.

In view of the specificity in the meaning of the term autotomy, as well as the confusion which has arisen from its broader use, and because of the lack of a general expression which would include all phenomena of a related character, a new derivative, appendotomy*, is hereby proposed to describe the loss of any appendage at prelocalized points of weakness through the activity of any force, irrespective of its origin. Autotomy, autotilly, and autospasy are then specific cases of appendotomy, differing from each other in the cause and nature of the disjointure.

While little research has been done with insects and no exhaustive canvass of the group has been attempted, even for those in which regeneration is known to occur, it would appear from the information at hand that true autotomy is not possessed by insects. But in spite of being deprived of special muscles to effect a reflex amputation, insects derive material advantage from the posses-

*This is admittedly a term of dual origins but by mixing the Latin and Greek sources the connotation was found to be more clearly apparent and the word more euphonious than any pure combination available. This should be as useful an expression as appendectomy, sociology, and other hybrid derivatives already established in the literature.

sion of predetermined loci of weakness known as breaking-points in as much as a leg or antenna may be easily severed at one of these points when subjected to an external pull (autospasy) as might be exerted in the grasp of an enemy.

AUTOSPASY

The roach, **Blattella germanica** (L.), appears to have several well-defined breaking-points, one on each antenna and two on each leg. No such weakness has been noted for the mouthparts or cerci, although separations may be caused in these appendages if sufficient stress is applied.

The antenna of the roach is the generalized structure which might be expected, consisting of three segments, a stout scape articulating with the antennifer of the head, a second somewhat smaller segment, the pedicel, and a long tapering flagellum which is made up of many subsegments. If the flagellum be grasped with forceps near the tip, a break will occur at any of the subsegments near the point of seizure with no indication of a specific breaking-point. But if the pull be exerted at the middle of the flagellum, or more basad, the separation always appears between the scape and pedicel. This certainly points to the presence of a congenital fragility between these two segments. The breaks nearer the apex of the flagellum probably represent only a graduated structural weakness in the annulations correlated with the tapering size of the subsegments and are not to be considered in the same light as the true breaking-point at the union of scape and pedicel.

The structure of all legs in the roach is approximately the same. The coxa is a rather large and somewhat flattened segment which articulates basally with the pleural coxal process and the trochantin, and distally with the trochanter. The trochanter is more or less firmly fixed to the femur so that there is no movement at this point but the femoro-tibial and the tibio-tarsal joints are free and may be readily flexed. The tarsus consists of five subsegments which are freely movable upon each other although no sclerotic points of articulation are present.

Two constant planes of detachment are apparent in each of the legs, one at the tibio-tarsal joint and the second between the trochanter and femur. The entire tar-

sus readily disengages from the tibia under the influence of a strain from the distal end, but no tendency toward fracture is evident between the subsegments. When stress is applied to the tip of the tibia, disjointure always occurs at the immovable junction of the trochanter and femur. Extreme force may cause separation at other joints if the normal fracture-planes are protected from strain, but under natural conditions such breaks have never been observed. The ease with which the legs may be detached indicates a congenital weakness at these points, but there is no evidence that true reflex sloughing (autotomy) occurs. In a few cases, where a tibia or femur had been bisected artificially, that portion of the leg remaining beyond the trochanter was subsequently found missing, but in no instance was there the immediate sloughing so characteristic of autotomy. It seems probable, then, that the loss of appendages with the roach is of the type know as autospasy, but that occasionally injured members may be voluntarily removed from the body (autotilly).

REGENERATION

Regeneration in the roach, as with all Arthropods, occurs only at the time of ecdysis, normally at the first moult following the amputation. If the injury is inflicted a comparatively short time preceding the moult, the reproduction of the lost part may be delayed until the end of the following instar. Naturally some time is required for the growth of the new tissues and complete formation cannot be effected in a few hours. Regenerated parts are usually reduced in size as compared with the normal structures, and frequently appear to be of little use to the insect since their movements are slow and clumsy as though the new muscles were not fully developed. With each subsequent moult, however, the reproduced structures grow larger and stronger and if given enough time may equal a normal appendage. Zeleny (1905) and Bennazzi (1929) have shown that the rate of regeneration is directly proportional to the size of the lost part or to the extent of the injury, and the mere fact that the reproduced parts may in time come to equal uninjured structures would point also to a more rapid growth in regeneration than is normal in the animal.

Antennal segments and subsegments of the flagellum are readily regenerated in the roach. If the break

has occurred between the subsegments near the tip of one of a pair of antennae, the two are usually almost if not entirely equal following the moult, certainly after a second moult. If the fracture is at the breaking-point between the scape and pedicel, complete regeneration is more slow. The renewed pedicel is approximately of normal size, but the flagellum will be reduced greatly in diameter as well as in length.

Cerci are regenerated in much the same way as the antennae, but no efforts were made to induce this phenomenon in the segmented appendages of the mouth-parts.

Quite naturally, the re-formation of the tarsus alone takes place with greater facility than when more of the leg segments are involved. This may be associated with the fact that the tibio-tarsal breaking point is somewhat less tenacious than the trochanto-femoral. At any rate, tarsi are regenerated almost invariably with the next moult and frequently may be of normal length. Without exception, however, the regenerated tarsus consists of but four subsegments. Brindley (1897, 1898) noted this unusual occurrence and discussed the confusion which resulted from the early descriptions of roaches wherein the tarsus was attributed as having only four subsegments. Illingworth (1916) records the same behavior for Hawaiian roaches, stating that "when tarsi are renewed, they lack the fourth segment in every case." It is not exactly clear just what is meant by the "fourth segment" but the present observations would indicate that either the second or third subsegment is the one involved. In the normal leg the second and third subsegments are more or less alike while the first, fourth, and fifth are fairly distinct and easily recognized even in the regenerated tarsus. The fourth subsegment is markedly smaller than the others and possesses a fleshy lobe on the ventral side. The penultimate subsegment in the renewed tarsus fits this description and is not at all like the third normal subsegment. Of course, the whole situation is obscured by the fact that the reformed subsegments are enlarged so that the total length of the four approximates that of the normal tarsus of five parts but the identity of the first and of the last two subsegments remains distinct throughout the procedure. This reduction in parts is characteristic of the tarsus even when additional segments are in-

volved in the regeneration and the normal number is not completed during any of the succeeding moults.

When the break arises at the union between trochanter and femur, or when the tibia or femur are bisected, the lost parts are regenerated at the next moult and, with the exception of the reduced number of subsegments in the tarsus and a diminution in size, the new structures are normal. It has been claimed (Brindley, 1897, 1898; Illingworth, 1916) that regeneration does not occur when the separation is closer to the body than the trochanto-femoral joint, but such has not proven to be entirely true. Bisection or forcible removal of the trochanter resulted in regeneration only perceptibly less rapid than when this segment was left intact. The effects of hemisecting the coxa are more severe. In fact, whether because of the more profuse bleeding or because of the greater extent of the injury, the incidence of moulting was considerably prolonged. In addition, a longer healing period is necessary between the amputation and the moult, for in several instances no indication of regeneration was displayed when this period was shorter than a week. The new leg after this manner of dismemberment was always of materially diminished size and frequently incomplete, consisting only of trochanter and femur in addition to the coxa, or perhaps also a rudimentary tibia. The missing segments are sometimes completed during later moults, but the new leg is seldom normal in size or strength.

Mutilation of one leg apparently has little effect upon the regeneration of another except in so far as the locomotion of the insect is impaired and its ability to feed thus hampered. Multiple injuries to legs or to legs and antennae seem to be repaired at the same time with no decrease in rate.

Staudinger (1930) has reported instances of homoeosis with **Carausius (Dixippus) morosus** wherein abnormal structures are interpolated between the segments of the regenerated appendages, or where normal segments are out of place or in reversed order. Similar phenomena have not been encountered in this species of roach, unless one considers the loss of a subsegment in the tarsus as a manifestation of this principle.

SUMMARY

The general term appendotomy is proposed to in-

clude all losses of appendages by Arthropods, whether this severance be effected by reflex sloughing (autotomy), by an extrinsic force (autospasy), or by self-amputation (autotilly).

In **Blattella germanica** (L.), appendotomy is effected only by autospasy in the majority of cases, but autotilly may occur. A similar condition undoubtedly prevails with most insects which exhibit any ability of regeneration.

Fractures normally occur at prelocalized points of weakness. The roach has at least fourteen of these breaking-points, one on each antenna between the scape and the pedicel, two on each leg at the trochanto-femoral and tibio-tarsal joints.

Appendotomy is usually followed by regeneration of the lost parts at the next ecdysis and in this species of roach missing segments of the antennae, cerci, and legs are readily restored. In the legs, the renewal may arise at the joint between any two segments, or even where a segment has been hemisected, but is more apt to originate at the breaking points. The facility with which regeneration takes place on the leg apparently decreases as the location of the injury approaches the body. In all cases observed when a tarsus had been replaced, whether alone or with other segments of the leg, it consisted of but four subsegments rather than the normal number of five.

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FIVE NEW SPECIES OF LEAFHOPPERS (HOMOPTERA-CICADELLIDAE)

R. H. BEAMER, Lawrence, Kans.*

E. juncea n. sp.

Resembling **E. rufostigmosa** Beamer but noticeably smaller and more slender, median stripe narrower, venter light, vertex acute, anterior point of foot not just a right angle.

General ground color semihyaline to muddy white, with distinct median red stripe. Vertex with mesal orange to red stripe, not touching eyes, continued as broader band across pronotum, occupying all of scutellum and most of clavus, outer margins of this band much brighter. Second pair of oblique vittae of elytra present, arising on Cu, anterior third lemon yellow, remainder red. Apex more or less infuscated. Venter stramineous.

Genitalia: Style with foot of medium size, heel prominent; base straight, anterior point short and sharp, posterior point long, almost half as long as foot, narrow. Aedeagus long, in lateral view, sides almost parellel, opening about one-third distance from tip.

Holotype male, allotype female, 2 males and 16 female paratypes, Likely, Florida, July 24, 1934, R. H. Beamer. Swept from scrub oak on sand dunes.

Erythroneura caerula n. sp.

Resembling **E. mixta** Beamer but black in color, shaft of aedeagus shorter, sides not parellel, apex enlarged, hooks recurved.

Color: Black throughout except lateral margins of vertex between eyes and apex and costal palque yellowish white. Costa beyond costal plaque usually wine red. Abdomen more or less black, remainder of venter light except mesosternum which is black.

Genitalia: Style with short foot; anterior point short, about a right angle; posterior point longer than foot, narrow, sides converging to sharp point. Aedeagus larger than in either **E. rubricata** Van D. or **E. mixta** Beamer, in dorsal view, wide at base, narrowing toward

*Contribution from Department of Entomology, University of Kansas

tip where it again widens to end in three recurved processes.

Holotype, male, allotype female, 5 males and 23 female paratypes, Barnes, Arkansas, June 8, 1931, R. H. Beamer.

This species was taken with brown specimens of **E. rubricata** Van D. from **Hypericium** sp. growing in low bottom lands.

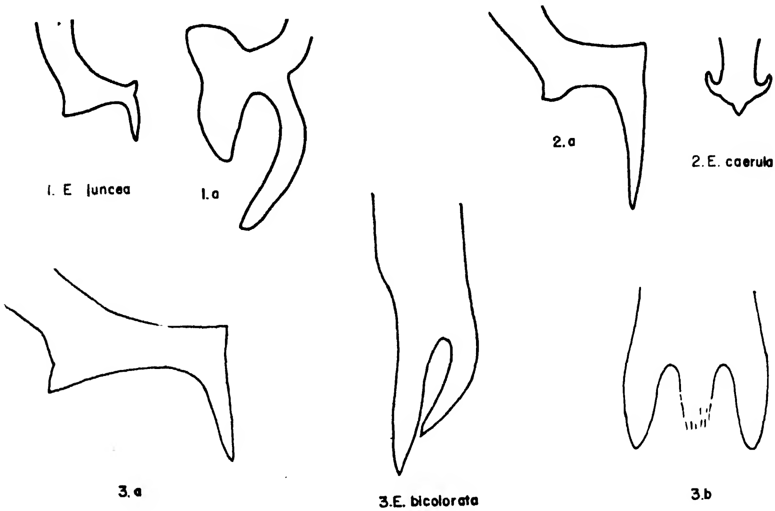
Erythroneura bicolorata n. sp.

Resembling **Erythroneura vulnerata** Fitch but easily distinguished from that species by having anterior half of body dark colored and posterior light, and by having a much larger chelicerate pygofer hook.

General ground color of anterior half dark brown of posterior semihyaline to white tinged with pink. Vertex with narrow median longitudinal white line enlarged at either end, a semblance of two spots on either side and vertex margin white. Pronotum with two rather definite triangle on posterior margin either side of middle, and anterior margin, especially the corners spotted with white. Scutellum more or less longitudinally striped with light. Elytra back to a posteriorly curving line from anterior margins of costal plaque through posterior third of clavus dark with some lighter areas, beyond this light more or less suffused with pink, apical cells somewhat infuscated. Venter dark, more or less marked with white.

Genitalia: Pygofer hook much larger than in **E. vulnerata,** bifid at apex, finger-like processes about as long as remainder of hook, almost touching at apex. Style with medium foot; heel large; base almost straight; anterior point slightly more than a right angle, posterior point narrow and sharp, about half as long as foot. Aedeagus typical of this group with rather narrow, slightly diverging processes.

Holotype male, allotype female, 2 male and 1 female, paratypes, Douglas Co., Kansas, R. H. Beamer; 1 male paratype Colfax, Pa., December 23, 1931, R. H. Beamer; 1 female paratype, White Co., Ill., March 31, 1929, P. W. Oman.



Hecalus balli n. sp.

Resembling **Hecalus bracteatus** Ball but more slender and female with vertex more than twice as long as width between eyes instead of barely longer than wide. Length female, 9.5 mm, male, 5.5. mm.

Female: Vertex slightly more than twice as long as width between eyes, foliaceous, lateral margins almost parellel on basal four fifths, apex rounded, median longitudinal ridge, small but distinct, continuing across pronotum, vertex slightly concave either side median ridge. Ocelli on margin about one third distance to apex. Elytra short, covering about the first two abdominal segments, one fourth shorter than vertex, apices rounding, venation distinct but reduced.

Male: Vertex rounding, almost semicircular, slightly wider between eyes than mesal length, no mesal ridge, margins not foliaceous, ocelli about one half distance to apex. Elytra longer than abdomen, venation distinct.

Color: Female stramineous with an indication of darker longitudinal lines on abdomen. Male milky white.

Genitalia: Last ventral segment of female with more pronounced excavation than in **H. bracteatus.** Male plates more slender than in that species and aedeagus with a pair of heavy processes arising basally on ventral

side of shaft and extending more than half its length.

Holotype female, Cochise, Ar., E. D. Ball, allotype male and numerous male and female paratypes Cochise, Ar., August 24, 1935, R. H. Beamer. Holotype and paratypes in collection of E. D. Ball, allotype and paratypes in Snow Entomological collection.

This species was swept from a native grass near the railroad a mile or so east of Cochise, Ar.

Cicadella curta n. sp.

Resembling **Cicadella cucurbita** Ball but smaller, vertex sharper and median longitudinal white stripe extending from anteclypeus to the apex of clavus. Length female 4.75 mm, male 4.50 mm.

Vertex distinctly wider than median length; apex conical distinctly less than a right angle. Pronotum with lateral margins narrow, a deep median indentation of the posterior margin gives it a bilobed appearance. Venation not too distinct; clavus with two veins; corium with two crossnervures. Elytra covering abdomen

Color:: General ground color stramineous. Median ivory stripe definite across scutellum, pronotum, vertex and post clypeus, bordered with fuscous. Black frontal arcs continuous where visible from above. Vertex with three pairs of black longitudinal stripes, first pair anterior to eyes, second touching ocelli and third, quite broad, bordering median stripe, continuing across pronotum and scutellum. Pronotum with an indication of the other two pairs. Elytra with veins whitish more of less bordered by fuscous, this dark coloring not approaching mesal margin closer than width of pronotal light stripe thus for length of clavus there is apparently a light band about twice as wide as the pronotal band.

Genitalia: Last ventral segment of female very broad, posterior margin sharply, triangularly produced with small mesal notch. Male plates smaller but about as in **C. cucurbita.** Aedeagus with long processes, thick on basal half, then sharply narrowed to lash like apices, right one much heavier and longer than left.

Holotype male, allotype female, and numerous paratypes, Roswell, New Mexico, July 16, 1936, R. H. Beamer. This species was swept from small patches (ten feet long) of a very short, thickly growing grass, often a half dozen sweeps of the net would yield 75 specimens. Adults and nymphs were present. Types in Snow Collection.

THREE NEW SPECIES OF PHYLLOPHAGA (COLEOPTERA, SCARABAEIDAE) WITH NOTES ON TWO SPECIES NEW TO KANSAS.

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Recently, while working over the Phyllophaga material of the University of Kansas, and incorporating my own into that of the Francis Huntington Snow Collection, the writer encountered three new species which seem worthy of record. Unless otherwise indicated all types are deposited in this collection.

Phyllophaga perita n. sp.

Length, 16 mm.; width, 8.5 mm.

This species should be placed in or near Group XVII of Horn (Revision of the Species of Lachnosterna of America North of Mexico, Trans. Amer. Ent. Soc., XIV, 1887).

Form oblong, distinctly wider behind. Color reddish-brown with head and pronotum of the same general color. Surface shining.

Antennae 10-segmented with the club equal in length to segments 3-7 combined; color reddish-brown with the club perceptibly lighter. Clypeus slightly but distinctly emarginate with the margins on either side moderately reflexed; surface of clypeus and front with very large coarse punctures, these not regularly placed, and some of which open posteriorly.

Pronotum equally coarsely punctured but not quite as closely as on the head, and the punctures irregular, variable in size; an invading smooth area at the base on either side of center of pronotum; pronotum nearly twice as wide as long with basal angles rounded and nearly obsolete; marginal line almost obliterated; widest at middle and rather suddenly convergent and straight to apex which is narrower than at base. About a dozen large yellowish hairs arising along the crenate sides. An erect hair arising from each discal puncture on the central and posterior portions.

Elytra very distinctly dilated posteriorly with the surface nearly regularly and finely punctured, and with

* Contribution from Department of Entomology, University of Kansas.

the sutural costa distinct though not prominent; discal costae feeble; a few hairs arising near the base of the elytra and on either side of scutellum. In some regions of the elytra, the surface is slightly pruinose.

Pygidium moderately convex, not quite twice as wide as long finely punctured except near apex which is nearly smooth and bearing a very fine longitudinal carina. Surface rather closely placed with short stiff hairs.

Abdomen more densely punctured at sides than at middle and with the punctures very fine; disc very slightly flattened at middle but without trace of longitudinal impression; abdomen very convex just before the last segment which is very finely and irregularly rugulose.

Both spurs of hind tibia free, narrowed, slightly curved; the inner spur extending to nearly two-thirds the length of the second tarsal segment, the outer spur as long as the first segment. Claws very similar on all tarsi, strongly curved, and with a very broad median tooth.

Metasternum with long, yellowish, but very fine hairs.

Holotype male, Baboquivaria Mts., Ariz., F. H. Snow.

The present species is unmistakibly associated with **heterodoxa** (Horn) and **latidens** (Schffr.) by the general form of its anterior and posterior claws.

The three species may be conveniently separated:

1. Claws of middle tarsi of males dissimilar.... **heterodoxa**
   Claws of middle tarsi of males similar .... (2)
2. Disc of pronotum with very coarse punctures, and with a hair arising from each; abdomen without longitudinal impression .... **perita**
   Disc of pronotum more finely punctured, and without vestiture; abdomen with a distinct longitudinal impression in the male .... **latidens**

Perhaps the most conspicuous difference by which this species is distinguished from all known species is in the peculiar type of genitalia. The claspers are united beneath, and from each side near the apex there arises a spatulate process which projects at about a 45 degree angle from the plane of the upper aspect. It is probable that in life the distal ends of the processes are horizontal, but drying of the specimen after death, and preparation of the genitalia for study have produced the twisted effect as figured.

Phyllophaga texana n. sp.

Length, 19 mm.; width, 9.5 mm.

This species is to be placed in Horn's Group IX.

Form elongate-oval, subdepressed, slightly wider behind. Uniformly dark brown as in **rugosa** (Melsh.) with which this species is associated. Surface shining.

Antennae 10-segmented, the club equal to segments 2-7 combined. Clypeus rather deeply emarginate with margin moderately reflexed; surface moderately, closely and evenly punctate. Sides of front nearly as closely punctate as clypeus, but with the interspaces becoming larger toward the center; clypeal suture slightly impressed.

Sides of pronotum indistinctly crenate, subangulate at middle thence convergent both anteriorly and posteriorly; wider at base than apex before which there is a vague sinuation; disc shining, moderately, irregularly, and rather sparsely punctate, a nearly smooth median area, the punctures becoming closer toward sides of pronotum; disc somewhat depressed on either side of the middle.

Elytra strongly rugose, the punctures everywhere obliterated, except near base and sides; discal costae nearly obsolete, the sutural one more distinct, and strongly rugose on the median two-thirds.

Pygidium convex, perceptibly wider than long, very finely and sparsely punctured, shining.

Abdomen finely and sparsely punctate below with a very few fine scattered hairs at sides; broadly flattened in the middle; penultimate segment with an oblique elevation extending posteriorly from near its anterior border, this segment deeply and suddenly depressed before the middle, coarsely punctate at sides, and becoming granulate toward the middle; last segment broadly concave and nearly smooth.

Fixed spur of hind tibia about one-half the length of the inner spur which is a little wider medially and slightly curved. Tooth of claw strong and median.

Metasternum finely and evenly punctate, and with the vestiture not dense.

Holotype male, Orange Co., Texas, Aug. 14, 1928. L. D. Beamer.

This species may be separated from its closest ally,

rugosa (Melsh.), by its more sparsely punctate head and pronotum, and by the shape of its genitalia. This structure is almost symmetrical, but nearly after the type of **knochii** (Schon.), and **rugosa.** It differs readily from either by having the posterior angles of both side pieces sharply acute and curved inward. The inside of the right clasper does not have the acute perpendicular ridge as in **rugosa,** but is smooth as in **knochii.** It is to be noted that the genitalia of this species nearly presents a borderline type between the truly symmetrical claspers, and those which are dissimilar. It is hoped that the accompanying figures will better show the peculiar characteristics of this organ.

Phyllophaga howei n. sp.

Length, 9-10 mm.; width, 5-5.5 mm.

About the size and form of **taxodii** Langston, but in Horn's table, keys to Group X based on antennal and tibial characters.

Form oblong-elongate, slightly wider behind. Color a pale, yellowish testaceous; head and pronotum darker and shining, elytra very slightly shining.

Antennae 9-segmented, testacious, the club nearly as long as the stem. Clypeus entire, rather strongly reflexed and excavated. Punctures moderate and separated by about their own diameters.

Sides of pronotum nearly parallel in basal half, though slightly sinuate before the hind angles, then evenly curved to the apex; the side margins distinctly crenulate and with a few hairs; disc with punctures rather closely placed and almost uniform in distribution, the interspaces being from about one-half to the width of the punctures.

Sutural costa of elytra distinct, the discal ones almost obliterated. Punctures on the elytra almost as closely placed as those on the pronotum, but scarcely as large or as deep.

Pygidium three-fifths wider than long, very convex, irregularly and moderately punctured on the disc before the apex which is very nearly smooth.

Abdomen broadly flattened medially, impunctate at middle but with very fine punctures laterally which become more numerous toward the sides; penultimate segment with a few long, erect hairs on either side of middle; last segment unmodified.

Holotype male, Fairfax, S. C., June 14, 1932, Edwin W. Howe, after whom the species is gratefully named. Paratypes, five males collected 15 miles northeast of Tallahassee, Fla., June 23, 1935, H. S. Peters. One male paratype labeled Leon Co., Fla., June 6, 1935, H. S. Peters. Paratypes in the collection of Mr. O. L. Cartwright, Clemson College, S. C.

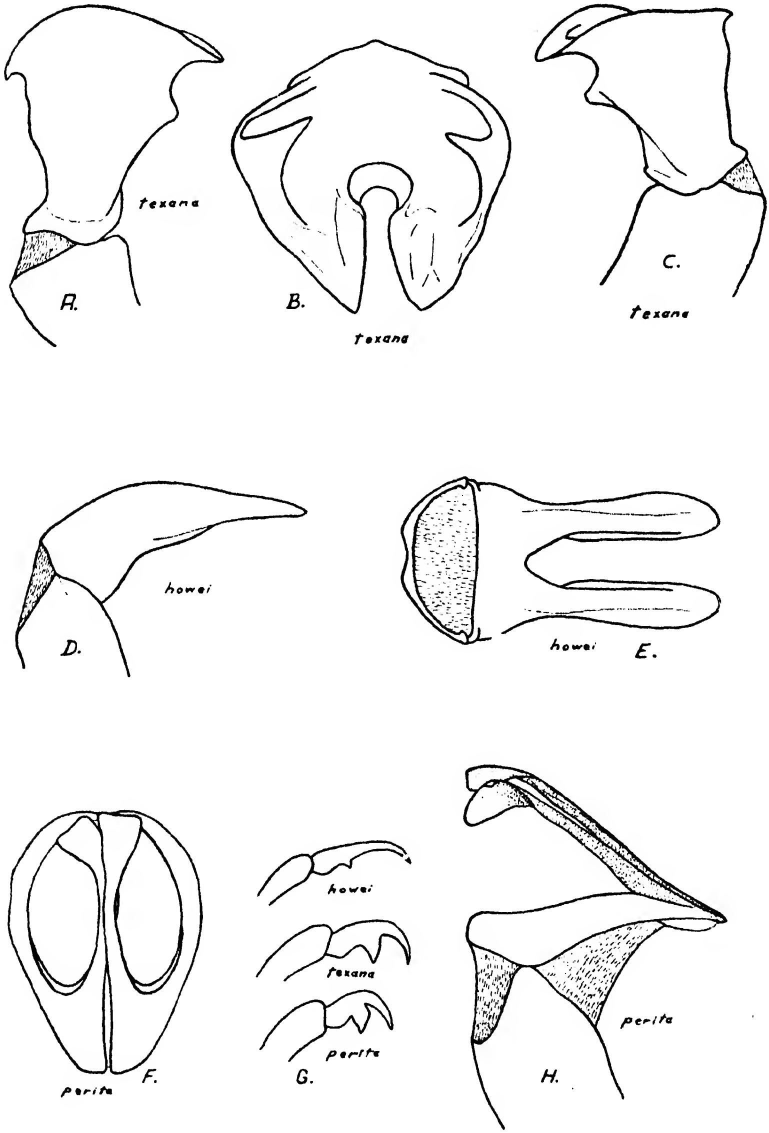
The paratypes are much darker and more shining than the type, and with punctures on the disc of pronotum slightly more irregular. In the small series, the fixed spur of the hind tibia varies from one-third to one-half the length of the inner spur.

This species is to be distinguished from the known members of Group X by its entirely glabrous upper surface, there being no evidence of hairs even on the front, which is characteristic of certain species within the group. In the type specimen a part of the abdomen was destroyed, and a description of its features was taken from the paratypes. The flattened surface approaches the unmodified type of **affabilis** (Horn). The genitalia are somewhat similar to that of **affabilis** but have the claspers united at their bases. Those of the latter species are free.

Explanation of Plate

A. Right lateral view.
B. Dorsal view.
C. Left lateral view.
D. Right lateral view.
E. Dorsal view.
F. Dorsal view.
G. Tarsal claws of new species described.
H. Right lateral view.

On May 30, 1935, near Galena, Kansas, Doctor R. H. Beamer and the writer took several specimens of **Phyllophaga arkansana** (Schffr.) feeding on oak, sassafras, and persimmon. May 23, 1936 near Elk City, Kansas, we took a single female of **P. karlsioei** (Linell) under a stone on a hillside. Both species were described from Arkansas, and are recorded here for Kansas for the first time.


texana
A.
B.
texana
C.
texana
howei
D.
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perita
H.

LIFE-HISTORY NOTES ON THE SPOTTED-SIDED CUTWORM (AGROTIS BADINODIS GROTE)[1]

H. H. WALKDEN, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

Introduction

In the course of a general study of the cutworms of the family Noctuidae occurring in the Middle West, considerable data have accumulated relative to some of the more obscure or less well known species of this group of moths. The Spotted-sided cutworm (**Agrotis badinodis** Grote) belongs to this category, and although no outbreak of this species has even been recorded, it seems worth while to place on record the observations regarding it made during the past few years. In the vicinities of Wichita and Manhattan, Kans., where the observations were made, the species is of uncommon occurrence. Crumb (1), in his consideration of the tobacco cutworms, states that the larvae have very rarely been found in tobacco fields, and on but one occasion have they been taken injuring plants in a plant bed. However, the writer's observations on the food habits of the species lead to the conclusion that it is of potential economic importance on cereal and forage crops. A change in the ecological factors restricting its abundance might easily bring this species into prominence; inasmuch as certain other members of the genus are of considerable economic importance in the United States.

Distribution

The present known distribution of this species comprises the northern Atlantic States and Canada, along the Atlantic Coast from New York to North Carolina, and westward to Iowa, Kansas, and Texas. (1), (3). Further investigations would probably enlarge this range.

Host Plants

The larvae evidently have a rather wide range of

1 Order Lepidoptera, Family Noctuidae.

food plants. Crumb (1) records clover, **Rumex crispus, Sisymbrium officinale, chickweed, Aster ericoides,** and **tobacco,** and states that they have a decided preference for **Rumex** and chickweed. The writer has taken the larvae in clumps of volunteer wheat, in surface trash along roadside hedges, and in grassy areas adjoining wheat and alfalfa fields. They were also taken at night, feeding on the tender leaves of alfalfa.

Seasonal history

There is but one generation annually of this species. During the years 1921-1930, inclusive, a record was kept of the Noctuidae taken at a baited trap at Wichita, Kans. In most years, the adults of **Agrotis badinodis** first appeared in the trap early in October. The greatest flight usually occurred during the first ten days of the month, although adults have been taken as late as November 2. Records of adults taken at trap lights, in 1934-1935, corroborate the results obtained with the baited trap.

The eggs are deposited soon after the females emerge, and hatch in about two weeks, normally in this region during the last ten days of October. In the laboratory, eggs deposited October 16 hatched October 30, at room temperature. The larvae feed to some extent in the fall and pass the winter in the larval stage, mostly in the third or fourth instar. In the latitude of Wichita, Kans., they no doubt feed to some extent when warm periods occur during the winter months. Field collections of larvae show that, by the last of March, a majority have passed the last molt. By April 20, feeding has practically ceased and they have entered the soil for pupation. Of the larvae collected in the field in March and early in April, the first pupation occurred on April 15 and nearly all had pupated by April 30. One larva did not pupate until May 16, and it is interesting to note that the adult emerged on September 26, the earliest date recorded in these observations. The summer is passed in the pupal stage within an earthen cell, the adults emerging early in October, thus completing the seasonal cycle. The seasonal history is shown graphically in Fig. 1.

Life cycle

The adult

The adults are short-lived, only about two weeks of

the life cycle being occupied by this stage. Adults taken at the bait trap, of unknown age, lived a maximum of ten days after capture, and averaged eight days. In confinement, the females deposited eggs on the cloth covering of the cage and on alfalfa leaves, and scattered eggs promiscuously over the surface of the soil. Eggs were not observed under natural conditions, but in the cages the moths showed no disposition to place their eggs in masses. Seventeen females, reared from egg to adult in captivity, were dissected within twenty-four hours after emergence, and the eggs counted. The maximum number of eggs observed was 1,300, the minimum 536, with an average of 880 eggs per female. Oviposition occurs during the night and was not observed.

The sexes are apparently about evenly proportioned. Of 49 adults secured in various rearings, 25 were females, this figure being slightly more than 50 percent. However, in adults taken at the bait and light traps the males greatly outnumbered the females. At bait, the proportion was four males to one female, while at light the ratio was seven to one.

The egg

In the laboratory, the incubation period of the eggs averaged about two weeks. No doubt it is somewhat longer under field conditions, owing to the lower outdoor temperature late in October. Eggs deposited October 16 hatched on October 30, and another group deposited October 18 hatched November 2.

The larva

In making observations on the larval instars, the following method was followed:

The newly hatched larvae were placed in homeopathic vials, one larva per vial, and a single alfalfa leaf supplied to each for food. The vials were then plugged with cotton and put in holes bored in plaster of Paris blocks, the plugged end in contact with the plaster. Moisture was supplied by absorption from the plaster, which was kept saturated with water. In this way the food supply was kept fresh for at least 24 hours, and was changed if necessary at the time of the daily observation. The larvae were observed daily and the molts recorded,

as were the measurements of the cast head capsules. After the third molt, the larvae were placed in 3-ounce salve tins partially filled with sterilized soil. The food supply was put on top of the soil.

Two generations were reared in this manner. However, the first generation was carried through the winter in the laboratory basement where the temperatures were too high to induce hibernation. As a result the larvae fed actively throughout the winter and became full grown the last of January. They lingered for about a month and then began to die in large numbers, so that by the end of March very few remained. Altogether 13 larvae pupated late in March and early in April. From these 4 adults were secured, emerging late in June and early in July, more than three months ahead of the normal emergence period. This record is presented here merely to show how the species can be thrown out of balance by abnormal conditions.

The second generation was begun with eggs deposited October 18, 1926. These hatched November 2. The larvae were kept at room temerature until November 9, when they were placed in an outdoor cave. The winter temperatures in the cave occasionally fell to near the freezing point, and were sufficiently low to render the larvae inactive from early in December to mid-February. During the latter part of February the larvae had all resumed feeding and by the last of April had entered the soil preparatory to pupation. The first pupa was noted on April 20 and by May 9 all the remaining larvae had pupated. The first adult emerged September 11, and the greatest number of moths appeared during the period October 3-11. The summary of the life cycle is presented in table 1.

As the larvae molted, the cast head capsules were measured, the greatest width as seen from the front being taken. These measurements were remarkably constant within the instar, the variability being least in the first three instars. In table 2 is given a summary of the head measurements, representing observations on more than 100 larvae for each instar.

Table 1.—Summary of life cycle of **Agrotis badinodis** Grote

	Number of days										
	Egg	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar	6th Instar	7th Instar	Prepupal	Pupa	Larva	Egg to Adult
Maximum	15	20	21	74	60	38	22	38	14	170	188	364
Minimum	14	6	8	21	28	17	9	25	3	119	169	315
Average	14.5	7.7	12.5	43.0	47.8	26.9	16.7.	29.9	8.2	154.2	180.4	349.4
Number observed	200	96	95	91	83	53	47	31	31	28	31	28

Table 2.—Summary of head measurements of larvae*

	Width of head capsule—mm.						
	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar	6th Instar	7th Instar
Number of individuals measured	154	167	168	158	127	111	0
Maximum width - - -	0.40	0.60	1.00	1.50	2.10	2.60	-
Minimum width - - -	0.35	0.55	0.70	1.15	1.55	2.10	-
Average - - - -	0.40	0.60	0.88	1.35	1.83	2.29	-

Footnote to table—
*Owing to the fact that in the final larval molt, the head capsule splits, no accurate measurement could be taken.

The pupa

Pupation takes place in the soil in an earthen cell constructed by the larva shortly after feeding ceases. A few weeks after pupation the pupal case becomes quite hard and it is difficult to determine whether or not the pupa is still alive since the pupa does not squirm but remains motionless within the cell. Of 28 individuals reared from egg to adult the longest pupal period was 170 days and the shortest 119 days, the average for the group being 154.2 days. Another group of 19 pupae from larvae collected in the field showed a maximum pupal period of 178 days and a minimum period of 133 days with an average of 165 days. This difference is probably due to the fact that the larvae in the life-cycle series were never subjected to freezing temperatures and consequently were slightly more advanced than larvae which had experienced winter conditions.

Description of the stages

Grote's original description of the adult appeared in the Canadian Entomologist (2). Smith (4) also gives a description of the adult. Descriptions of the various stages are presented by Crumb (1). The interested reader is referred to the above named publications.

Parasites and disease

Owing to the scarcity of the larvae, only meager notes on parasites and disease could be secured. Over a period of several years, a total of 38 larvae were collected. Of this number, 4 were parasitized by undetermined internal parasites, no adults of which were obtained. Two other larvae were killed by fungus, probably **Beauveria** sp. Crumb (1) records **Paniscus geminatus** Say and an undetermined dipteron as parasitic on this species, as well as several diseases.

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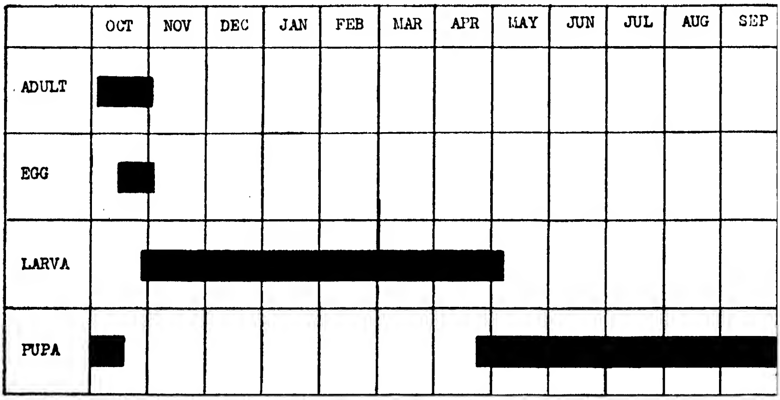
1890 Revision of the Genus Agrotis. U. S. Nat. Mus. Bul. 38, pp. 61-62.

Fig. 1. Seasonal History Chart, <u>Agrotis badinodis</u> Grote



NOTE

FOOD OF **BIBIO PAINTERI**

In the Journal of the Kansas Entomological Society for October, 1935 (vol. 8, pp. 145-146), the writer noted the feeding habits of some adult Bibionidae, tentatively identified at the time as **Bibio xanthopus** Wied. Attention is hereby called to the fact that these notes henceforth be referred to **Bibio painteri** James, since Mr. M. T. James has described the specimens under that name in a recent paper on "Some new western Bibionidae" (Amer. Mus. Novitates, 832, p. 2. March 26, 1936).

CURTIS W. SABROSKY.

A MOLE-CRICKET AT BAY

MELVIN E. GRIFFITH, Lawrence, Kansas*

Many observers—some of them unintentional naturalists—might prepare out of personal experience a scathing indictment of the skunk for demonstrated antisocial conduct. Those who have fully received evidence of the ill-favored vertebrate's displeasure will appreciate the extremity of the measure serving also in the defense of that unique insect, the mole-cricket. Several writers** have discussed the very sticky, fetid discharge of **Gryllotalpa** and **Scapteriscus,** and the glands responsible for its production. To these admirable reports from the laboratory may be appended the following account from the field.

Pursuing a list of favorite collecting sites, the Limnology Class of the University of Kansas came to the Leavenworth County State Lake one sunny afternoon in April, last year. Along the shore the erratic tracery of the small molish burrowings of **Gryllotalpa** attracted a number of students who were soon digging excitedly in the loam. Most of the crickets, however, were evidently couched uneasily in their deeper burrows, for only a single bemused female was at length uncovered scarcely a yard from the water-edge. This specimen, **Gryllotalpa hexadactyla** Perty, remained hopefully 'possuming until lifted from its wrecked tunnel by the tweezers of the discoverer. It tumbled back to earth where desperate efforts to return underground were rudely discouraged. At bay, with threatening tweezers darting at its head and a bottle descending to receive its body, the odd little animal had provocation enough for its subsequent action.

Curving up the tip of the abdomen and spreading the two long caudal filaments, the mole-cricket forced out over its head a jet of fluid which vanished in the soil several inches away. The repugnant odor, so vividly described by Baumgartner, was hardly detectable among the usual earthy smells of damp lake shore. The body of the creature seemed innocent of offensive vapors which

*Contribution from the Department of Entomology, University of Kansas.

**Notably Dr. W. J. Baumgartner: Science, N. S., Vol. XXI, No. 544, p. 855, June 2, 1905, and Kans. Univ. Sci. Bull., Vol. V, No. 18, pp. 315-318, March, 1910.

is less surprising, for the material is certainly lethal to the species* which may be expected to rid itself completely of each discharge. The skunk, it will be remembered, is not an unpleasantly odoriferous animal, personally.

The amazing part of the mole-cricket's single defiant act was not in its performance, which is quite familiar to students of living specimens, but in its direction. That the fetid substance may be depended upon to protect the soft abdomen from rear attack, probably for the most part from cannibalistic associates, in the burrow, has been shown by the experiments of Baumgartner. A certain amount of aiming toward points of irritation in the rear has been noted also by that writer. But a shrewdly directed shot at an approach upon the head argues for the mole-cricket an intelligent use of its capabilities which entitles it to the respect of its adversaries and more careful attention from biologists.

HESSIAN FLY EGGS AND FREEZING TEMPERATURES.

W. T. EMERY, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

An opportunity to observe the effect of freezing temperatures on the vitality of eggs of the hessian fly occurred unexpectedly in January, 1934. Several eggs on a blade of wheat were covered with water in a dish and placed in a cold room to prevent hatching before the larvae were desired. During the night a cold wave developed and the following day the wheat leaf and eggs were found embedded in ice. When thawed out the eggs hatched normally. These observations led to the planning and execution of an experiment to test the effects of freezing temperatures on hessian fly eggs.

McColloch (1) has noted that "temperatures as low as -21 degrees F. were recorded with no appreciable mortality to the flaxseed. Full grown larvae have also been known to survive a temperature of -16 degrees F." He further says "Temperatures of about 32 F. are fatal

* W. J. B., 1910.
(1) The Hessian Fly in Kansas. Tech. Bull. 11, Kans. State Agr. Coll., 1923.

to the adults and in many cases to the eggs and migrating larvae."

On January 5, 1934, blades of wheat bearing newly deposited eggs of the hessian fly were placed in a shell vial stoppered with wet cotton and exposed in a weather shelter at Wichita, Kans. At the end of 10 days, and each week thereafter until February 5, eggs were removed from the vial and brought into the laboratory. Some 276 larvae hatched from these eggs, a portion of which were transferred to wheat plants and developed normally to the puparium stage. A record of the exposure periods and of the minimum temperatures to which these eggs were subjected is shown in table 1.

Table 1

Effect of freezing temperatures on the egg stage of the hessian fly

Date eggs were exposed to outdoor temp.	Date eggs were removed to laboratory	Eggs removed to laboratory	Days exposed	Minimum temp. to which eggs were exposed	Days with temp. below freezing.	Eggs hatched	
		Number	Number	Degree F.	Number	Number	Percent
Jan. 5	Jan. 15	200	10	17	7	66	33
Do.	Jan. 22	150	17	17	11	42	28
Do.	Jan. 29	145	24	14	17	125	86
Do.	Feb. 5	97	31	11	22	43	44

The eggs removed to the laboratory on February 5 had been subjected to 200 hours of freezing temperatures, 18 of which were below 20 degrees F. with a minimum of 11 degrees F.

It is possible that the high relative humidity maintained in the vials by the use of the wet cotton stoppers was a factor in enabling the eggs to withstand the freezing temperatures.

SOME NEW SPECIES MICROVELIA (VELIIDAE, HEMIPTERA)

A. P. McKINSTRY*

As a biproduct of a thoroughgoing morphological study of the genus Microvelia it is necessary to describe the new species below. In the University of Kansas Collection there are nearly ten thousand specimens from various places in the western hemisphere and these comprise forty-one species. The species containing apterous forms can be separated into Groups as follows:

Group I: Protergum not produced caudad of the suture between pro and mesotergum.

Group II: Protergum covering part or all of the mesotergum. The boundary between meso and metatergum being marked by the presence of two tiny pits in a suture about halfway between the median line and the pleural region.

Group III. Protergum covering all of mesotergum and most of metatergum, leaving only small triangular sclerites (metanotal angles) exposed.

Microvelia beameri n. sp.

Size: Apterous male, length, 2.3-3 mm., width, 1 mm.; female, length, 2.5-3 mm., width, 1.25 mm. Winged male, 2.5-3 mm.

Color: Similar to **M. americana** (Uhl.), perhaps yellow-orange markings on protergum and connexivum a little darker. Venter dark brown.

Structural Characteristics: Antennae; segments 1 and 2 about equal, 3 slightly longer and 4 a little shorter than 1 or 2. **Tarsi;** about all the same length, segment 1 of middle tarsi not shorter than 2, also not shorter than segment 1 of hind tarsi. **Legs;** front femur of male with spine one-third distance from apex, hind femur of male without spines usually, hind tibia of male with brush-like comb as in **M. americana** (Uhl.). **Abdomen;** venter of male covered with long silky hair, somewhat concave. First genital segment with characteristic tufts of hairs near ventral posterior margin. Ventral posterior margin of first genital segment curving anteriorly at median line.

Location of Types: Holotype, winged male, Baboquiviri Mts., Ariz., 7-18-32, R. H. Beamer; **Allotype,**

*Contribution from Department of Entomology, University of Kansas

winged female, Orange Co., California, 7-14-29, R. H. Beamer; **Holomorphotype, Allomorphotype,** apterous male and female, Lemon Cove, California, 7-24-29, R. H. Beamer, in Francis Huntington Snow Entomological Collection, University of Kansas. **Paratypes** and **paramorphotypes,** numerous from the Southwest and California.

Comparative Notes: Similar to **M. americana** (Uhler) except larger and longer. Antennal segment 3 longer than 4 whereas **M. americana** is opposite. First genital segment characteristic.

Data on Distribution:

Arizona: Coconino Co., 7-1-29, R. H. Beamer; Cochise Co., 7-29-27,, R. H. Beamer; Baboquiveri Mts., 7-18-32, R. H. Beamer; Huachuca Mts., 7-8-32, R. H. .Beamer; Santa Rita Mts., 7-17-32, R. H. Beamer; Santa Cruz Co., 8-4-27, R. H. Beamer; Tubac 6-25-33, Miami, 7-22-32, Maricopa, 7-2-29, R. H. Beamer.

California: Winters, 8-6-29, L. D. Anderson; Santa Ana Co., 7-30-32, R. H. Beamer; San Diego Co., 7-4-29, L. D. Anderson; Atascadero, 7-19-33, R. H. Beamer; Indio, 7-24-29, L. D. Anderson; Holtville, 7-2-29, R. H. Beamer; Lemon Cove, 7-24-29, R. H. Beamer; Calaveras Co., 5-29-31, Usinger; Gaviota, 7-29-33, R. H. Beamer; Salinas, 7-18-33, R. H. Beamer; Orange Co., 7-14-29, R. H. Beamer.

Texas: Valentine, 7-13-27, R. H. Beamer.

Mexico: Satillo Coahuila, 11-21-32, L. D. Tuthill.

Microvelia fasciculifera n. sp.

Size: Apterous male, length, 3-3.5 mm., width, 1 mm. **Apterous female,** length, 3.2-3.5 mm., width, 1.2-1.5 mm. Winged male, length, 3-3.5 mm., width, 1.4 mm.

Color: Ground color dark brown spotted with silvery white pubescence, transverse orange spot on protergum completely separated in middle, orange marks on connexivum absent. Legs of uniform light brown, slightly darker at joints. Winged protergum may have broken transverse spot or it may be entire, posterior margins yellow-orange not meeting in middle. Not much contrast between color of veins and cells of wings. Venter silvery grey.

Structural Characteristics: Two unique characters are observed in the males; retrorse spine on hind femur

one-third distance from base, and last abdominal sternite with cone shaped tuft of bristles. The females are large and the widest of abdomen of the southwestern species. **Antennae;** segments 1 and 4 equal, slightly longer than 2 and 3, which are equal. **Legs;** hind trochanter of male with tiny black tubercle on posterior surface. Hind tarsal segment 1 very slightly shorter than mid-tarsal segment 1. **Abdomen;** last tergite of male, square or wider than long. First genital segment with semicircular rim of short bristles just peeping out beyond last abdominal sternite in dried specimen. Anal lid and hypandrium, rounded, without lateral processes. **Thorax;** protergum of apterous form like **M. americana** (Uhl.) in not covering any of mesotergum.

Location of Types: Holotype, winged male, Huachuca Mts., Arizona, 7-8-32, R. H. Beamer; **Holomorphotype,** apterous male, Chiricahua Mts., Arizona, 7-8-32, R. H. Beamer; **Allomorphotype,** Alfred, Texas, 7-24-28, R. H. Beamer, in Francis Huntington Snow Entomological Collection, University of Kansas. Numerous paramorphotypes.

Comparative Notes: This is a typical member of Group I, which includes **M. americana** (Uhler) but unique characters mentioned above separate it from all others. The retrorse spur is sometimes degenerated to a mere speck, and again may be quite prominent.

Data on Distribution:

Arizona: Chiricahua Mts., 7-8-32, R. H. Beamer; Huachuca Mts., 7-8-32, R. H. Beamer, Santa Rita Mts., 7-17-32, R. H. Beamer.

Texas: Alfred, 7-24-28, R. H. Beamer.

Microvelia myersi n. sp.

Size: Winged male 1.6 mm. long, .6 mm. wide. Other forms not known.

Color: Ground color dark brown with markings of dull yellow. **Winged form;** protergum dark brown with transverse yellow band, posterior margins dark brown. Wings transparent white with light brown veins and darker markings in cells. All cells with white markings. Median cell with dark spur projecting basally from distal cross-vein. This mark does not touch a vein except at the distal side of the cell. It is not a vein. Venter, dull blue, connexivum yellow-orange. Legs white at bases,

brown distally.

Structural Characteristics: Antennal formula— 1:2:3:4::14:9:18:30.

Legs; Hind femur of male with several short spines, hind tibia with many sharp spines pointing toward apex. Front femur without spines. Hind femur not twice as thick as hind tibia, ratio, femur:tibia::5:3. Other legs with femora as thin as tibiae.

Tarsi; Mid-tarsal segment 1, shorter than hind-tarsal segment 1, ratio, M1:H1::7·8.5. Fore-tarsi longest, front tibia not twice as long as front tarsi.

Thorax; Only the winged form is known to me but according to antennae, legs, and genitalia, I expect the apterous protergum to be similar to that of **M. albonotata** Champion and to be of the Group II type. **Abdomen;** small tubercle on median line of posterior margin of sixth (next to last) abdominal sternite of male.

Location of Type; Holotype; winged male, labeled Trinidad, 20.xi.1928, J. G. Myers, B. M. 1929-170; Exch. with British Museum; at Light; in Francis Huntington Snow Entomological Collection. Described from two winged male specimens.

Comparative Notes; The tiny tubercle on the sixth abdominal sternite is unique, also the genitalia are quite distinctive. All characters indicate a strong relationship to **M. albonotata** Champ. but this species is noticably smaller.

Data on Distribution:

Trinidad; 20.xi.1928, J. G. Myers

Corumba; Matt Grosso, (Purchased from Staudinger)

Microvelia peruviensis n. sp.

Size: Winged male, 1.8 mm. long, .6 mm. wide; winged female, 2.0 mm. long, .7 mm. wide; apterous male , 1.6 mm. long, .6 mm. wide; apterous female, 1.6-1.8 mm. long, .7 mm. wide.

Color: Ground color dark brown with markings of yellow. **Winged Form;** with usual transverse yellow-orange band on protergum, posterior margins of protergum not yellow. Wings with prominent veins of dark brown, with white cells between. Apical cell with ovoid white spot surrounded with dark brown. Medial cell with brown streak projecting inward from posterior

margin, not a vein. Legs brown, bases yellow. Venter, lead-blue. **Apterous Form;** Protergum with yellow transverse band, meso and metatergum yellow, metatergal triangles brown. Abdomen outlined in brown at sutures.

Structural Characteristics: Antennal formula—1:2:3:4::14:9:19:21.

Legs: Hind femora twice as thick as tibia. Ventral surface of hind femora covered with short sharp spines. Apex of front tibia of male nearly as thick as front femur. **Tarsi;** front tarsi longer than middle and hind tarsal segments. First segments of middle and hind tarsi slightly shorter than second segments. **Thorax** apterous protergum barely covering a very small part of the mesotergum so that it resembles Group I. Other characters being considered we can easily see that this species is most closely related to **M. albonotata** Champion and therefore belongs in Group II. The winged form has no light stripe or spot running back from transverse orange-yellow spot on protergum as in **M. albonotata** Champion. **Abdomen;** seventh abdominal tergite of male slightly wider than long, ratio W:L::12:9. Seventh tergite about as long as fifth plus sixth. **Genitalia;** first genital segment of male prominent, hypandrium and anal lid lacking lateral projections or points as in **M. albonotata** Champ. Left clasper much larger than right, both straight, pointed at tip.

Location of Types: Holotype, winged male, Peru, S. America, Langunas Villa, Department of Lima, 1-8-34 to 6-1-34, F. Woytkowski; **Allotype;** Peru, S. America, Rio Rimac, 11-27-34, F. Woytkowski; **Holo and Allomorphotype;** apterous male and female, Peru, S. America, Lurin, Department of Lima, 11-3-34, F. Woytkowski; in Francis Huntington Snow Entomological Collection, University of Kansas. Short series of Paratypes and Paramorphotypes.

Comparative Notes: This species is closest in winged form to **M. albonotata** Champion, but it lacks the tubercle on the second abdominal sternite and the fourth antennal segment is shorter in comparison with the third than that of **M. albonotata.** The apterous form has a unique type of protergum and should be recognizable at once by it.

Data on Distribution:

South America

Peru; Dept. Lima, Lagunas Villa, June 1, 1934; Dept. Lima, Nov. 3, 1934; Rio Rimac, Nov. 27, 1934, F. Woytkowski.

Microvelia hungerfordi n. sp.

Size: Winged male, 4 mm. long, 1.3 mm. wide; **winged female,** 4 mm. long, 1.4 mm. wide; **apterous male,** 3.8 mm. long, 1.1 mm. wide; **apterous female,** 4 mm. long, 1.4 mm. wide.

Color: Ground color brown with rusty yellow markings. **Winged form;** transverse orange-yellow band on protergum present. It may or may not continue around on sides of prothorax. Posterior margins of protergum dirty-yellow, not broken at median line. Wings uniformly brown, veins indistinct. Veins in corium area sparsely covered with short shining hairs. Legs brown. yellow at bases. Venter shining lead-blue, sparse white pubescence covering all of ventral part of body. **Apterous form;** thorax and abdomen covered thinly with irregular shining white hairs. Markings indistinct except for transverse orange-yellow spot on protergum and rusty-yellow posterior margins of protergum.

Structural Characteristics: Antennal formula—1:2:3:4:;23:32:27:33.

Legs: femora and tibiae of males without spines. Femora not over twice as thick as tibiae. Front tibia more than twice as long as front tarsus. **Tarsi:** mid-tarsal segment 1: segments 2::19:18. Hind tarsal segment 1: segment 2 :: 25:17. **Thorax;** apterous protergum covering all of mesotergum except a tiny rim between phragmal pits. Protergum not fused with rest of thorax so that it will break away neatly. Distance between eyes: length of protergum :: 12:21. **Abdomen;** length of seventh tergite of male: width :: 12 : 10. Length of seventh tergite about equal to length of sixth plus fifth. Last abdominal sternite of male pinched together posteriorly to form keel-like ridge. **Genitalia;** first genital segment concave on ventral surface, two triangular projections on ventral surface near posterior margin. Anal lid and hypandrium without projections. Clasper triangular in outline, nearly as wide as long.

Location of Type: Holotype, allotype, winged male and female; **holomorphotype, allomorphotype,** apterous

male and female, labeled Argentina, S. A., La Granja Alta, gracia Cordoba, 1923, A. Bruch, in Francis Huntington Snow Entomological Collection, University of Kansas.

Comparative Notes: This species is similar to **M. longipes** Uhler as to thoracic tergum, but it is most closely related to **M. braziliensis** n. sp. which is slightly smaller. The most satisfactory character used in separating them is the antennae. The sternal keel on the last sternite of the males is unique in the two species. **M. hungerfordi** n. sp. and **M. braziliensis** n. sp.

Data on Distribution:

South America

Argentina: La Granja Alta, gracia Cordoba, 1923. A. Bruch.

Paraguay: Caraveni L. Miantis, 10-30-24, F. Schade.

Microvelia braziliensis n. sp.

Size: **Apterous female,** 3.1 mm. long, 1.1 mm. wide; **apterous male,** 3. mm. long, .9 mm. wide.

Color: Ground color brown with dull yellow markings. **Apterous form;** protergum with transverse orange-yellow band, posterior margins not yellow. Connexivum dull yellow. Sixth and seventh tergites of abdomen yellow-orange, nearly glabrous. Legs dull-yellow-orange, tips of segments darker. Venter yellow with dark lateral stripe. Entire body covered with short white irregular shining hairs.

Structural Characteristics: **Antennal formula**—1:2:3:4::20:18:31:33.

Legs; no spines on femora or tibiae of males. Femora about twice as thick as tibiae or less. Front tarsus less than half as long as front tibia. Mid-tarsal segment 1 : segment 2 :: 18: 14. Same is true of hind tarsi. Mid-tarsal segment 1 equal to hind tarsal segment 1. **Thorax;** protergum extending back over mesotergum exposing only a very small rim of posterior portion of mesotergum between phragmal pits. Distance between eyes : length of protergum:: 9: 12. **Abdomen;** Length of seventh tergite : width :: 10 : 8. Length of seventh tergite : fifth plus sixth :: 10: 9.5. Last sternite of male pinched together to form a keel-like ridge. **Genitalia;** first genital segment concave on ventral surface with two triangular projections near posterior margin. Anal lid and hypandrium without projections. Clasper triangular.

(To be continued in Vol. 10, No. 2)

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SOME NEW SPECIES MICROVELIA (VELIIDAE, HEMIPTERA)

A. P. McKINSTRY

(Concluded from Vol. 10, No. 1)

Data on Distribution:

South America

Brazil; Rio de Janeiro, Dr. A. Lutz.

Location of Type: Holotype, Allotype, apterous male and female, Brazil, S. A., Rio de Janeiro, Dr. A. Lutz, in Francis Huntington Snow Entomological Collection, University of Kansas. Several **paratypes.**

Comparative Notes: This species is like **M. hungerfordi** n. sp. in genitalia, last sternite, shape of legs, thorax and head, but the third and fourth segments are much longer and thinner than the latter. Also in **M. hungerfordi** n. sp. midtarsal segment 1 is shorter than hind tarsal segment 1, while they are equal in this species. This species (**M. braziliensis** n. sp.) and **M. hungerfordi** n. sp. are unique in the possession of a keel-like ridge on the last sternite of the males.

Microvelia cerifera n. sp

Size: Apterous form, length, 2.2 mm., width .9 mm.

Color: Markings same as **M. fontinalis.**

Structural Characteristics: Antennal formula—1:2:3:4::80:52:66:112.

Tarsi; protarsal segment longest, mid-tarsal segment 1 about as long as segment 2 less distance beyond junction of claws to apex. Hind tarsi same as above. No comb on apex of hind tibia. **Thorax;** protergum covering all of meso and metatergum except lateral triangular metatergites or metanotal angles. Longest distance between eyes very slightly shorter than length of protergum at median line; ratio 25:27 respectively. **Abdomen;** 7th abdominal tergite of male wider than long, shorter than 6th plus 5th. Anal lid with lateral processes having brushes at tip. Female abdomen not normally reflexed over abdominal tergites.

Location of Types: Holo and **Allotype,** apterous male and female, Scott Co., Kansas, 6-19-25, R. H. Beamer, 15 **paratypes,** same locality.

Comparative Notes: This species has been confused with **M. fontinalis** Bueno. The male genitalia, viewed externally will separate them upon close examination, and antennae will also serve since in **M. fontinalis** Bueno, segment 1 is very nearly equal to 2, while in **M. cerifera** n. sp. segment 1 is noticeably longer than 2. The Antennal formula for **M. fontinalis** Bueno is—1:2:3:4::64:60:66:122.

Data on Distribution:

Kansas: Scott Co., 6-19-25, R. H. Beamer; Cheyenne Co., 7-1-26, R. H. Beamer.

Colorado: Ft. Collins, 5-12-99.

New Mexico: Torrance Co., July 1925, C. H. Martin.

Microvelia guatemalensis n. sp.

Size: Apterous male, 2.2-2.5 mm. long, .8 mm. wide; winged male, 2.4-2.6 mm. long, 1 mm. wide.

Color: Ground color dark brown, markings in yellow-orange. Transverse neck spot present in both forms. Apterous thoracic tergum without other orange markings. Winged protergum with posterior lateral margins orange-yellow, not meeting at median line. Connexivum marked with orange. Legs brown, bases yellow. Wings brown, veins dark brown. Venter lead-blue.

Structural Characteristics: Antennal formula—1:2:3:4::17:18:23:20.

Legs; femorae very slightly swollen, fore and hind femora of males without spines. Hind tibia with round brush mounted on barely perceptible pedicel. **Tarsi;** mid-tarsal segment 1 shorter than 2. Hind tarsal segments equal. **Thorax;** apterous protergum not projecting over mesotergum. **Abdomen;** seventh abdominal tergite as wide as long, slightly shorter than tergites 5 plus 6. **Genitalia;** First genital segment with irregular brush of anteriorly pointing hairs on ventral surface. Posterior ventral margin slightly truncate. On median line, cephalad of brush of hairs, four black dots show in cleared mounts.

Location of Type: Holotype; Holomorphotype; Guatemala Salto Escuintla. 1934, F. X. Williams, in Francis Huntington Snow Entomological collection, University of Kansas. Four **Paratypes.**

Comparative Notes: Apterous thorax similar to others of Group I. This is the only species of the group that lack spines on both fore and hind femur of the male.

Data on Distribution:

Central America

Guatemala: El Salto Escuintla, 1934, F. X. Williams.

Microvelia californiensis n. sp.

Size: Apterous male, 2.7-3.3 mm. long, 1.1-1.3 mm. wide; apterous female, 2.9-3.1 mm. long, 1.4-1.7 mm. wide.

Color: General ground color dark brown, protergum with transverse orange band, outer half of connexivum orange outlined with brown, legs smoky yellow to orange. Sides of protergum, abdominal tergites 2, 3, 5, 6, 7, and connexival segments 3, and 6 silvery. Venter silvery lead-blue to dull lead-blue.

Structural Characteristics: Antennae; indistinguishable from some other members of Group I,

Legs; fore femur of male swollen, not black with one or more short spines on ventral surface. Hind femur of male not swollen as much as front femur. Mid-tarsal segment 1 slightly shorter than hind tarsal segment 1. Apex of hind tibia with round brush-like comb. **Thorax;** protergum not covering any of mesotergum. **Abdomen;** last tergite of male wider than long. First genital segment with posteriorly pointing bristles (similar to **M. gerhardi** Hussey) on a slightly raised welt which is about half as prominent as that of the latter species Anal lid and hypandrium rounded, without lateral projections. Ventral surface of first genital segment concave.

Location of Types: Holotype and **Allotype,** apterous male and female, Lafayette, California, 7-14-33, R. H. Beamer; in Francis Huntington Snow Entomological Collection, University of Kansas.

Comparative Notes: Probably most closely allied to **M. gerhardi** Hussey, and resembles **M. irrasa** Drake and Harris in first genital segment and has a tendency toward hairiness but it is not nearly as large or so hairy as **M. irrasa.**

Data on Distribution:

California: Berkeley, 4-26-33, Jean Linsdale; Leona Heights, 7-15-33, R. H. Beamer; Leguna Mts. 7-6-29, R. H. Beamer; Lafayette, 7-14-33, R. H. Beamer; San Diego Co., 7-4-29, L. D. Anderson; Bakersfield. 7-24-29, R. H. Beamer; Gaviota, 7-19-33, R. H. Beamer.

Microvelia schmidti n. sp.

Size: Male, 3.6 mm. long, 1.1 mm. wide; female, 3.2 mm. long, 1.3 mm. wide.

Color: Ground color dark brown. Apterous protergum with transverse orange band. Abdomen covered uniformly with silvery white hairs. Connexivum with orange spot on each segment. Legs dark brown to black, except base of femora, trochanter, and coxa, which are yellow. Venter lead-blue. Wings dark brown with veins indistinct.

Structural Characteristics: Antennal formula—1:2:3:4::35:43:53:38.

Legs: Hind femur of male with three to five spines on inner surface, front femur without spines. Femora swollen very little. Apices of front and hind tibiae, with small round brush of very short hairs on a pedicel about half as long as the width of the tibia or a little longer. **Tarsi:** Hind tarsal segment 1 decidedly longer than 2, ratio 1:2::10:8. Mid-tarsi, about equal, ratio 1:2::6:6. **Abdomen** Seventh tergite about as wide as long, length equal to length of fifth plus sixth tergite. **Genitalia:** First genital segment deeply sunken on ventral side nearest base, semi-circle of short hairs on ventral surface near posterior margin.

Location of Type: Holo and **Allotype,** winged male and female, Rio Virilla, Costa Rica, 12-26-31, Heinrich Schmidt; **Holo** and **Allomorphotype,** apterous male and female, San Jose, Costa Rica, 1932, Heinrich Schmidt. Several paratypes and paramorphotypes from the two localities above.

Comparative Notes: This is one of the very largest species in Group I. The spine-like brushes on the apices of the fore and hind tibiae of the male are unique. The short fourth segment of the antennae with its yellow base and dark apex is also sufficient to separate the females as well as the males from all other species.

Data on Distribution:

Central America

Costa Rica: San Jose, 1932, H. Schmidt; Rio Virilla, 12-26-31, H. Schmidt; Rio Torres, 2-10-32, H. Schmidt.

Microvelia hidalgoi n. sp.

Size: Length 2.3-2.5 mm., width .8—1 mm.

Color: Ground color brown. **Winged form;** protergum with transverse rusty-orange spot touching anterior margin. Humeral angles rusty-orange. Posterior margins of protergum light yellow, broken at middle, each yellow area arc-shaped with the chord being the posterior margin of the protergum. Wings light mottled brown, veins light tan, prominent, white spots in each cell. Legs yellow tinged with brown. Venter yellow with dark streak on sides. Silky pubescence covering venter. **Apterous form;** protergum with transverse spot as above. Abdomen rusty orange with sclerites outlined in brown. Venter and legs as above.

Structural Characteristics: Antennae formula—1: 2:3:4::10:9:14:17-20. Variation noted in the thickness of segment 3 and in the length of segment 4. **Legs;** no spines on legs of male or female. Femora about twice as thick as tibiae. **Tarsi;** Mid-tarsal segment 1: segment 2:: 12:11. Same true of hind tarsi. **Thorax;** protergum covering all of mesotergum and all of metatergum except lateral triangles (Group III). Length of apterous protergum: distance between eyes ::21:15. **Abdomen;** length of seventh tergite of male : width :: 12:14. Length of seventh tergite of male : fifth plus sixth :: 12:17. **Genitalia;** first genital segment short, rounded, posterior ventral margin evenly curved. Anal lid and hypandrium without lateral projections. Clasper bluntly triangular in outline, not twice as long as wide.

Location of Type: Allotype: Holotype; San Jose Costa Rica, Heinrich Schmidt, 1932. **Holomorphotype, Allomorphotype,** Rio Virilla, Costa Rica, 12, 26, 31. Heinrich Schmidt, in Francis Huntington Snow Entomological collection, University of Kansas.

Comparative Notes: According to apterous protergum this species is most closely related to **M. fontinalis** Bueno, **M. cerifera** n. sp., and **M. williamsi** n. sp. It is more elongate than **M. fontinalis** Bueno, **M. cerifera** n. sp. or **M. rufescens Champ.** There is nothing particularly unique about this species except the coloration of the wings and protergum.

Data on Distribution:

Central America

Costa Rica: Rio Virilla, 12-26-31, Heinrich Schmidt; San Jose, 1932, Heinrich Schmidt.

NEW SPECIES OF STONEFLIES (PLECOPTERA)

P. W. CLAASSEN, Cornell University

Herewith are described nine new species of North American Plecoptera. Included also is a description of the male of **Perla nona** Needham and Claassen which was unknown at the time when this species was first described. A discussion is also included on the synonomy of **Nemoura stigmata** Banks and **Megaleuctra spectabilis** Neave. While I have not thrown the generic name **Megaleuctra** Neave into synonomy with **Udamocercia** Enderlein I think that perhaps they are synonomous. Until the genotype of **Udamocercia** can be more carefully studied it is perhaps desirable to retain the name **Megaleuctra.**

Acroneuria delta, new species

Plate 1, figure 1

Length to tip of wings, female, 31 mm.

General color dark brown. Head with a lighter spot in the ocellar triangle and lighter outside of the hind ocelli; hind ocelli nearly twice as close to each other as to the eyes. Pronotum narrower than head, narrowed behind; median field about one-sixth the width of pronotum; discs moderately rugose; general color brown but with the front and lateral margins yellowish. Wings lightly fumose; Sc ends slightly beyond the cord; field beyond the cord with about 10 crossveins in forewing. Abdomen yellowish; cerci somewhat darkened toward the tip.

Female. Subgenital plate of eighth abdomen sternite slightly produced and notched in the middle as shown in figure.

Male. Unknown.

Holotype, female, Yellowstone River, Wyoming, August 5, 1921, F. M. Sales (Cornell Entomological Collection).

Paratypes, one female, Sinks Canyon, Wyoming, June 6, 1934, P. Schulthess. This female is generally a little lighter in color but structurally agrees with the above description.

Acroneuria prolonga, new species

Plate 1, figure 4

Length to tip of wings, female, 25 mm.

General color dark brown, head a little wider than pronotum, yellowish behind and with a dark area over the ocellar triangle. The hind ocelli a little closer to each other than to the eyes.

Pronotum almost uniformly brown, narrowed behind, angles quite sharp, and the surface rather rugose. In both the fore and hind wings there are two or three cross veins beyond the cord.

Female. Eighth abdominal sternite produced into a broadly rounded subgenital plate which is narrowed at the base and extends almost across the entire ninth sternite.

Male. Unknown.

Holotype, female, Bridger Mountains, Montana, June 19, 1914. (Cornell Entomological Collection). This species most nearly approaches **Acroneuria arida** Hagen, but differs both in venation and in the structure of the subgenital plate.

Nemoura complexa, new species

Plate 1, figures 2, 3, 6.

Length to tip of wings, male, 7 mm.

General color reddish brown with uniformly lightly infuscated wings and with the veins of the pterostigma much darker than the rest of the veins.

Head much wider than pronotum, in fact the pronotum is not as wide as the distance across the occiput of the head; ocelli about twice as close to eyes as to each other. Both head and pronotum mottled with darker brown. Cervical gills absent. Hind wings with a narrow anal area.

Male. Abdominal segments one to eight largely membraneous and only sclerotized along the dorsal anterior margins; segments nine and ten heavily sclerotized. Cerci long, incurved, fully sclerotized and on the inside near the tip with a tooth. Supraanal process upcurved, enlarged and of complex structure, consisting of two median sclerotized bars flanked with a bulbous lobe bearing near the tip 3 or 4 spines and at the base on each side with about 6 large spines directed outward; anteriorly there projects a 3-pronged semi-membraneous process from about the middle of the supra-anal lobe Subanal lobes narrow at base, flattened and much enlarged toward the tip and outwardly sharply pointed. Sub-

genital plate long, slender and bifurcate at the tip; ventral lobe narrow and about 2½ times as long as wide.

Female. Unknown.

Holotype, male, Artists Brook, Essex County, New York, June 11, 1933, C. R. Crosby and H. Deitrich (Cornell Entomological Collection).

Paratypes. One male, same locality June 28; one male, Chapel Pond, Essex County, New York, June 27; one male, Slaterville, New York, May 30.

This species most nearly approaches **Nemoura serrata** Claassen but differs greatly in details of the genital structures.

Leuctra sara, new species

Plate 1, figures 7, 8, 11.

Length to tip of wings; male, 7½—8 mm.; female, 9 mm.

General color dark brown to blackish. This species resembles **P. occidentalis** Banks, but differs from this species as follows:

Male. The cerci are modified into heavily sclerotized processes possessing five prongs, a small one directed inward at the base and each of the two other prongs with a shorter prong on the inside. The supra-anal process is narrower than that of **occidentalis** and possesses an upcurved slender prolongation at the tip. The ventral lobe is a little wider than in **occidentalis;** the subgenital plate is a little more prolonged and almost truncate at the tip, with just a suggestion of emargination at the center.

Female. The eighth abdominal sternite is produced into a bilobed, widely emarginate subgenital plate, whose lobes bear long hairs. In general there is very little difference between the subgenital plate of this species and **occidentalis** except that the emargination in this species is not as great as it is in **occidentalis.**

Holotype, male; allotype, female; Ringwood Lloyd Preserve, near Ithaca, N. Y., May 10, 1927. (Cornell Entomological Collection)

Paratypes. Two males, same locality; six males, 1 female, Copala Falls, N. Y., April 11, 1924, Crosby and Chapman; one male, E. Jewett, Catskill Mts., N. Y., April 18, 1913; two males Ithaca, N. Y., April 18, 1928.

Leuctra crosbyi, new species

Plate 1, figure 10.

Length to tip of wings, male, 8 mm.

General color reddish brown. Head very slightly wider than pronotum; a narrow dark line connecting the hind ocelli. Pronotum hardly wider than long, narrowed behind; median longitudinal field about one-fourth as wide as pronotum. Wings reddish fumose.

Male. Seventh abdominal tergite medially prolonged into a spatulate-shaped sclerotized process which extends partly onto tergite eight and with a shorter narrow sclerotized process on each side; subanal lobes broad; tittilators shorter than subanal lobes, slender and curved forward; ventral lobe about as wide as long.

Female. Unknown.

Holotype, male, Mt. Pisgah, Frying Pan Gap, N. C., October 15, 1926, C. R. Crosby (Cornell Entomological Collection).

This species most nearly approaches **L. triloba** Claassen but is larger in size and is easily recognized by the process on the seventh abdominal tergite.

Leuctra bilobata, new species

Plate 1, figure 9.

Length to tip of wings, female, 7 mm.

General color reddish brown. Head a little wider than pronotum; smooth over ocellar triangle but rugose back of ocelli. Pronotum slightly narrowed behind. Wings reddish fumose.

Female. Eighth abdominal sternite prolonged into a bilobed subgenital plate which reaches entirely across the ninth sternite.

Male. Unknown.

Holotype, female, Selkirk Mts., British Columbia, July 18, J. C. Bradley, (Cornell Entomological Collection).

Paratype, female, Rogers Pass, Selkirk Mts., August 1, 1908, J. C. Bradley.

This species is similar to **L. occidentalis** Banks, but the subgenital plate is so different in both of these females that I believe it to be a distinct species.

Taeniopteryx raynoria, new species

Plate 1, figure 13

Length to tip of wings, male, 13 mm.; female, 14 mm.

General color reddish brown with moderately fumose wings but with an irregular clear band across the forewing in the area of the cord.

Head a little wider than pronotum; a lighter spot in the ocellar triangle and lighter inside the eyes; occiput rugulose. In general appearance similar to **Taeniopteryx pacifica** Banks, but differing in the genital structures.

Male. Supra-anal process directed upwards, curved rearwards, sharply pointed and bearing posteriorly a bulbous knob at the tip of which projects a small finger-like process; at the base of each cercus an inward directed process, rounded at the tip and well sclerotized; subanal lobes asymmetrical and consisting of variously modified membraneous structures; tenth tergite bears very large sclerotized processes as indicated in the illustration; subgenital plate extends considerably beyond the tip of the tenth segment, and there is no ventral lobe. The cerci are composed of eight segments.

Female. The genital structures of the female are very similar to **Taeniopteryx pacifica** Banks, except that the plate of the ninth abdominal sternite is more broadly rounded.

Holotype, male, allotype, female, Yosemite, California, June 1, 1936, H. J. Raynor (Cornell Entomological Collection).

Allotype, one female, same locality.

Taeniopteryx vanduzeea, new species

Plate 1, figure 12

Length to tip of wings, male, 8 mm.

General color dark brown with lightly infuscated wings.

Head rather uniformly brown and smooth except for slight rugosities on the occiput; hind ocelli much closer to eyes than to each other. Pronotum widened behind and with moderately rugose discs. Wings with a slanting cross vein beyond the cord between costa and subcosta. Coxae without gill scars.

Male. Supra-anal process broad, flattened, directed upward and slightly recurved, heavily sclerotized and quite broadly rounded at the tip; back of supra-anal process and attached to its base are two membraneous bulbs, the first one reaches almost to the tip of the supra-anal process and is smaller than the second one which, under high magnification, shows it to be finely spinulose; subanal lobes asymmetrical and each composed of three variously modified membraneous processes which recurve upward; cerci six-segmented; at the base of each cercus a large inward and anterior-ward directed sclerotized process; tenth tergite bears no appendages but each side is elevated into smooth knobs. Subgenital plate greatly produced and at the base with a ventral appendage which is about as wide as long.

Holotype, male, G. Alpine Cr., Tahoe, California, E. P. VanDuzee, (Cornell Entomological Collection). This species differs from other western species of this genus in possessing a ventral appendage on the ninth sternite of the male as well as in details of genital structures.

Megaleuctra stigmata Banks

1900 **Nemoura stigmata** Banks, Trans. Am. Ent. Soc. 26:244.

1930 **Megaleuctra spectabilis** Neave, Can. Ent., 46:4.

A study of the male type of **Nemoura stigmata** Banks shows that it is identical with **Megaleuctra spectabilis** Neave which was described from female specimens. A comparison of the wing venation has revealed the identity of these two species. Bank's type was collected in Winnipeg, B. C., June 17 and Neave's specimens were collected May 29, and June 18, Purcell Range, B. C. I also possess a female of this species from Alberta, B. C., bearing the date June 1, 1927.

In 1905 Enderlein, Zool. Anz. 28:814, described as a new species **Leuctra antarctica** End., a female from Antarctic South America (Feuerland). This female has the eighth abdominal sternite produced into a long process very similar to **Megaleuctra stigmata** Banks, but Enderlein's drawing and description does not show a second process of sternite nine. It is possible that in a dry specimen the details of the genitalia were not clearly seen.

In 1909 Enderlein, Zool. Anz. 34:394 erected the genus **Udamocercia** with **Leuctra antarctica** Enderlein the genotype. In 1912 Enderlein, Kungl. Sv. Vet. Akademiens Handlingar 48, No. 3, plate 4, fig. 43, illustrates the wings of **Udamocercia antarctica** Enderlein. The venation is similar to that of **Mega'euctra stigmata** Banks and both fore and hind wings possess the clouded spot in the pterostigma.

After a careful study of the above situation I am inclined to believe that **Megaleuctra** Neave is a synonym of **Udamocercia** Enderlein.

Megaleuctra complicata, new species
Plate 1, figure 15

Length to tip of wing, male, 16 mm.

General color dark brown with infuscated wings whose veins are dark and with a dark brown spot in the pterostigma beyond the end of Sc. This spot is present in both fore and hind wings.

In general it agrees quite well with **Megaleuctra stigmata** Banks but it differs in genital structures and in details of wing venation. Neave's figure of **spectabilis** Neaves equals **stigmata** Banks shows at the origin of Rs in the forewing a small stub of a cross vein. This stub is present also in the male type **stigmata** as well as in a female of stigmata which I possess from Alberta, B. C. While the presence of this stub may not be of significance it is worthy to note that in this new species it is absent. However the structural differences in genitalia have led me to describe this as a new species.

Male. The first eight abdominal segments are normal, moderately and evenly sclerotized; on the 9th tergite there are two knobs which are narrower than in **stigmata** Banks. The ninth sternite bears a subgenital plate which is produced into a rather narrow process and extends to the base of the upturned probe. At the base of the ninth sternite originates a very large ventral appendage which is membraneous below and heavily sclerotized above. Tenth tergite cleft and bearing at the posterior margin two sclerotized lobes which extend forward over the cleft. Supra-anal process largely membraneous except at the tip where it bears a downward pointing lightly sclerotized process. The supra-anal lobe is guarded on each side by a heavily sclerotized flattened

process which originates at the base of the cerci and apparently is homologous to the small inward pointing processes which occur in some of the species of **Nemoura.** Posteriorly at the base of the supra-anal process there are two membraneous lobes which, when fully extended, are at least half as long as the cerci. The basal portion of the tenth tergite or perhaps the subanal lobes have been fused into an upcurved probe which is heavily sclerotized on the inside and surrounded by a membraneous sheath; the tip is bifurcate. Cerci long, slender, moderately sclerotized and covered with rather long hairs.

Holotype, male, Corvallis, Oregon, March 28, 1930, Ruth J. Norberg (Cornell Entomological Collection). When I studied the type of **Nemoura stigmata** Banks, the specimen was not relaxed and consequently the full details of the genitalia could not be studied. However, I believe that this species is distinct from **stigmata** and I base this on the fact that the lobes on the ninth tergite are smaller, the genitalia different, and on the fact that this new species was collected in March, whereas the specimens of **spectabilis** Neave equals **stigmata** Banks were collected in May and June.

Perla nona, Needham & Claassen
Plate 1, figures 5, 14.

The original description of this species was based upon a single female specimen from Oregon. Recently I have received a female and two males of this species from Professor Dimick in Oregon, and I am herewith describing the male and including figures of the male genitalia.

Male. Length to tip of wings, 16—17mm. The general coloration of the head and the pronotum agree with the original description of the species. The seventh abdominal sternite is slightly produced rearward suggestive of a transverse lobe; ninth sternite slightly produced and broadly rounded; tenth tergite cleft and with finger-like processes directed inward. Supra-anal process bluntly pointed and not greatly sclerotized. The subanal lobes quite sharply pointed and somewhat directed backward.

Two females, one male, Metolius River, Oregon, September 24, 1932, R. E. Dimick.

Explanation of Plate

Fig. 1. Acroneuria delta new species, female.

Fig. 2. Nemoura complexa new species, dorsal view.

Fig. 3. Nemoura complexa new species, ventral view.

Fig. 4. Acroneuria prolonga new species, female.

Fig. 5. Perla nona Needham & Claassen, male.

Fig. 6. Nemoura complexa new species, male, side view.

Fig. 7. Leuctra sara new species, male.

Fig. 8. Leuctra sara new species, cercus of male.

Fig. 9. Leuctra bilobata new species, female.

Fig. 10. Leuctra crosbyi new species, male.

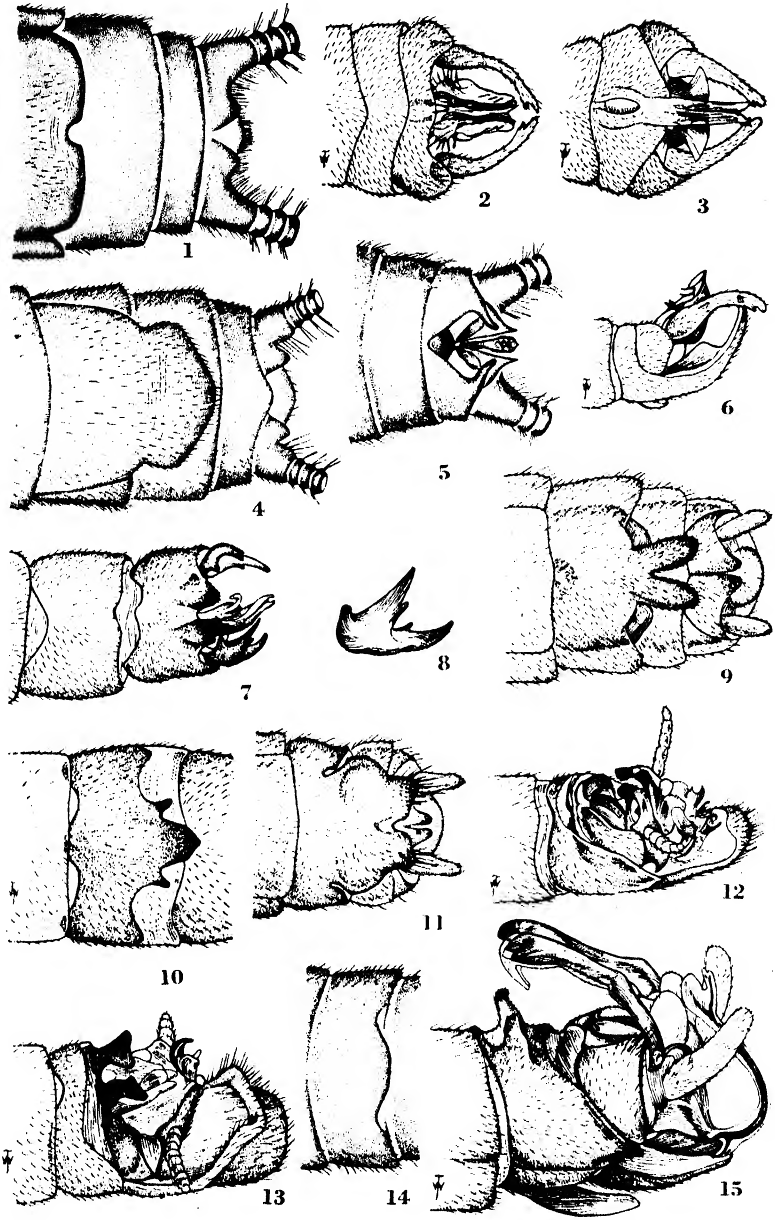
Fig. 11. Leuctra sara new species, female.

Fig. 12. Taeniopteryx vanduzeea new species, male.

Fig. 13. Taeniopteryx raynoria new species, male.

Fig. 14. Perla nona Needham & Claassen, male, showing 8th abdominal sternite.

Fig. 15. Megaleuctra complicata new species, male.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NOTES ON THE LIFE HISTORY OF THE BRONZED CUTWORM (1) IN KANSAS

H. H. WALKDEN, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

INTRODUCTION

The bronzed cutworm is a pest of minor importance on cereal and forage crops in the Eastern Great Plains region. Normally the species is uncommon but occasionally favorable conditions permit its increase to a point where grasslands, especially bluegrass areas, suffer moderate damage by larval feeding. For this reason it seems well to publish the results of observations made in Kansas during the past few years.

DISTRIBUTION AND ECONOMIC IMPORTANCE

This species is recorded as occurring throughout the northern part of the United States east of the Rocky Mountains, with Colorado, Kansas, Missouri, Tennessee, and Virginia as the approximate southern limit of its range. It also occurs in injurious abundance in eastern Canada, particularly New Brunswick (5). In Kansas the writer has taken adults at Cherryvale, Wichita, Manhattan, Hays, and Garden City; in Nebraska, at Lincoln, and also at Scottsbluff in the extreme western part of that State.

A review of the published records on the bronzed cutworm reveals that it has been recognized for many years as an injurious species, particularly in the Northeastern States and in eastern Canada. In 1888, Lintner (7) mentions it as attacking corn. Forbes (3) records much damage to grass in New York in 1881, and states that about 3,000 acres of meadow and pasture were destroyed near Columbus, Ohio, in 1886. Gossard (6) lists the bronzed cutworm among the most common and destructive cut-worms in Ohio. In Iowa (2) it is recorded as having been unusually abundant in pastures during 1926 and 1927.

HOST PLANTS

The larvae have a very pronounced preference for

(1) *Nephelodes emmedonia* Cram. Order Lepidoptera, family Noctuidae.

bluegrass and have been recorded in the literature (**1, 2, 3, 4, 5, 7**) as grass and cereal plant feeders. They have also been known to climb fruit trees and attack the buds and leaves. The writer has taken the larvae from the crowns of bluegrass (**Poa** sp.) and wild rye (**Elymus virginicus** L.), and also from under sacks placed in grassy alfalfa fields.

For detailed descriptions of the egg, larval, and pupal stages the reader is referred to Crumb (**1**).

SEASONAL HISTORY

In Kansas there is but one generation of the bronzed cutworm annually. In this respect its seasonal history is similar to that exhibited by this species in the northern part of its range. As pointed out by Crumb (**1**), however, the higher average temperatures encountered in more southern latitudes tend to shorten the time necessary for the completion of the development and in order that the seasonal cycle occupy a full year there must therefore be a quiescent period in one or more of the stages. In the bronzed cutworm this period of retarded development occurs in the egg and larval stages.

The following discussion of the seasonal history of the species is based on observations made in the vicinities of Wichita and Manhattan, Kans.

The adults make their appearance about mid-September, and the flight continues into the early part of October, the greatest number of adults being present during the first week of that month. The eggs are deposited shortly after the emergence of the females, but do not hatch until the following January and February. In the insectary, eggs deposited in the first week of October hatched during the last of January and the first half of February. The larvae become full grown by the last of April. During the first ten days of May the majority cease feeding and form their earthen pupal cells. A few stragglers continue feeding until the last of May. After the formation of the pupal cells the larvae remain

quiescent during the summer months, pupation beginning about August 15. The pupal period occupies about four weeks and the seasonal cycle is completed with the emergence of the adults in September and early in October. The seasonal history is shown graphically in figure 1.

LIFE CYCLE

The Adult

Although the adults may be taken over a period of about 4 weeks during September and October, it is quite probable that the average length of their life is about 2 weeks. Individuals emerging from the life-cycle series lived a maximum of 16 days, and a minimum of 3 days. In cages, oviposition began 2 days after emergence, the eggs being scattered promiscuously among the soil particles at the bottom of the cage. The females showed no disposition to place their eggs in masses, or on the foliage of stems of the alfalfa in the cages. One female deposited 117 infertile eggs before death and on dissection the ovaries were found to contain 393 eggs. Another female deposited 361 fertile eggs but the eggs remaining in the ovaries after death were not counted.

In order to obtain information on the fecundity of the species, 16 freshly emerged females were dissected and the eggs contained in the ovaries were counted. The maximum number of eggs observed was 1,381 and the minimum 533, the average for the group being 1,071.

In the reared specimens, the number of males exceeded that of the females. Of 92 adults secured in various rearings, 58 percent were males. At the bait and light traps, scarcely any females were taken. The sex was observed in 253 adults from the bait trap and the ratio was 1 female to 20 males.

The Egg

Under outdoor insectary conditions, the incubation period of the eggs averaged approximately 127 days. (Table 1.)

TABLE 1.—Summary of life cycle of the bronzed cutworm in Kansas

Stage		Specimens Observed	Maximum	Minimum	Average
		Number	Days	Days	Days
Egg		361	145	98	126.8
Larval					
First instar		255	48	21	30.0
Second instar		252	15	5	10.5
Third instar		245	14	4	9.0
Fourth instar		244	13	3	8.2
Fifth instar		239	20	5	13.5
Sixth instar	Larvae having only six instars	116	171	138	158.3
	Larvae having seven instars	68	19	7	15.6
Seventh instar		27	169	63	147.3
Total larval		143	248	147	230.8
Pupal		69	34	24	27.6
Egg to adult		69	397	305	381.0

It was found that eggs deposited on the same date varied considerably in their incubation period. For example, one lot of eggs deposited September 28, 1927, began hatching on January 18, 1928, and the last larva appeared February 20. Other lots of eggs deposited on September 30, October 3, and October 6 showed a similar variation. The hatching period for the 361 eggs under observation extended from January 12 to February 25. Slightly more than 75 percent of the eggs hatched during the period January 30 to February 8.

The Larva

In making observations on the larval instars, the

proçedure was as follows:

The eggs were kept in an outdoor insectary during the winter months, and as the larvae emerged they were placed in homeopathic vials, one larva per vial, with leaves of bluegrass supplied for food. The vials were plugged with cotton and put in holes bored in plaster of paris blocks, the plugged end in contact with the plaster. A supply of moisture was introduced by absorption from the plaster, which was kept saturated with water. In this way the food was kept in good condition for at least 24 hours. The larvae were observed daily and the molts recorded. The food supply was replenished when necessary. After the third molt the larvae were transferred to 3-ounce salve tins partially filled with sterilized soil. The food, consisting of bluegrass leaves, was placed on top of the soil.

The larvae were kept in the insectary until April 17, when they were placed in a cave. On June 16 they were removed to the laboratory basement, where they remained until the emergence of the adults in September and October.

The first instar is rather prolonged, owing to the fact that the eggs hatch at a time of the year (the early part of February) characterized by alternating warm and cold periods. The later instars, which occur during March and April, are much shorter, the exception being the final instar which carries the species through the summer months in a quiescent state.

By May 15 practically all of the larvae had ceased feeding and had constructed their pupal cells.

As the larvae molted, the cast head capsules were measured, the greatest width as seen from the front being taken. A summary of the head measurements is given in table 2.

TABLE 2—Summary of measurements of width of head capsule in the different instars of the larvae of the bronzed cutworm.

Instar		Maximum Width	Minimum Width	Average Width	Heads Measured
		Mm.	Mm.	Mm.	Number
First		0.60	0.50	0.56	255
Second		1.00	.80	.88	250
Third		1.55	1.20	1.38	239
Fourth		2.40	1.90	2.18	240
Fifth	Larvae having only six instars	3.90	3.00	3.44	170
	Larvae having seven instars	3.30	2.60	2.90	66
Sixth	Larvae having seven instars	4.30	3.60	4.06	67
Final instar (a)		—	—	—	—

(a) No measurements of the final instar were made owing to the fact that in the final larval molt the head capsule splits, and no accurate measurements were possible.

The Pupa

Pupation takes place in the soil in an earthen cell. In the life-cycle series, pupation was about 2 weeks later than for larvae collected in the field. As a result, the average period from egg to adult was extended to 381 days, as shown in table 1. The final larval instar for specimens reared from eggs averaged 147.3 days, while for larvae collected in the field this instar averaged 135.0 days. The pupal period for field-collected larvae averaged 2.1 days less than for the group reared from the egg. The reason for these differences is not clear.

Measurements taken of 83 pupae showed the average length to be 27.4 mm. and the average breadth 8.8 mm. The pupae ranged in length from 24 to 33 mm. and in breadth from 8.0 to 11.0 mm.

LARVAL HABITAT, PARASITES AND DISEASE

A total of 169 larvae were collected on various dates

while these studies were in progress. The majority were taken in April, from their hiding places in clumps of bluegrass. In making these collections the writer was impressed by the remarkable protective coloration of the larvae. Removed from its natural habitat, the larva is very conspicuous, its pale longitudinal stripes being in sharp contrast with the bronzed, dark brown body color. Stretched out among the stems and dead leaves at the base of bluegrass clumps, the larva blends admirably with its surroundings.

Evidently the larval habit of hiding deep in bluegrass crowns protects the species from parasitic attack, since only 1 percent of the larvae taken were parasitized. These were parasitized by undetermined Hymenoptera, no adults of which were secured.

However, the species is subject to a devastating wilt disease, and 32 percent of the larvae under observation died from this malady. In addition, 1 percent of the larvae succumbed to an undetermined fungous disease.

Muesebeck (8) records **Apanteles rufocoxalis** Riley as a parasite of **N. emmedonia** form **violans** Guen.

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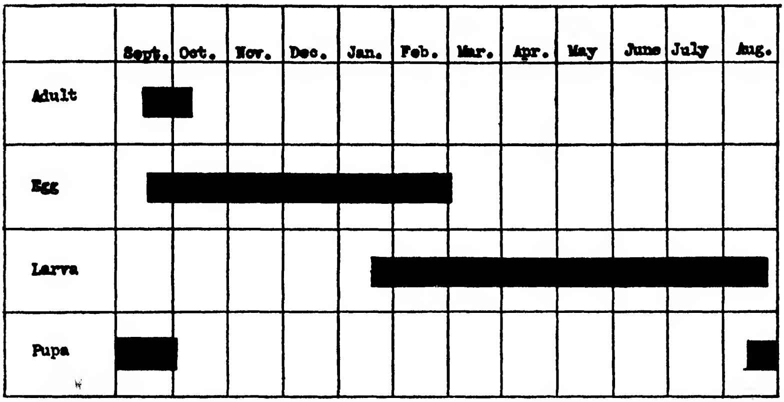
Figure 1—Seasonal History of Bronzed Cutworm in Kansas.



NOTES ON HEBECEPHALUS WITH THREE NEW SPECIES. (HOMOPTERA-CICADELLIDAE)

R. H. BEAMER, Lawrence, Kansas*

Hebecephalus blandus (Gill.)

Deltocephalus blandus Gillette, C. P., Colorado State Agri. Exp. Sta., Bull. 43, p. 26, 1898.

This species was described from two females, one from Ft. Collins, and one from Calhan, Colorado. It is seemingly a rare form in its type locality and was only rediscovered in numbers in 1935 by P. W. Oman near Santa Fe, New Mexico, and again in 1936 by myself at Las Vegas, New Mexico, St. Johns and Flagstaff, Arizona.

The male is like the female in form and color but much smaller in size and has the elytra as long as the abdomen. Length 1.75 mm.

Genitalia: Valve more than twice as long as last ventral segment, angular; plates as wide at base as valve, at least twice as long, gradually narrowing to rounded apices. Pygofer long, without hooks. Styles almost as long as plates, slender on outer two-thirds. Aedeagus of medium length, in dorsoventral view with two pairs of lateral processes, one apical giving the apex a triangular appearance and the other near middle retrorse. Neither pair more than about half as long as width of shaft.

*Contribution from Department of Entomology, University of Kans.

The male, Las Vegas, New Mexico, July 13, 1936, R. H. Beamer, described above, is designated allotype.

Hebecephalus neomexicanus Tuthill

Hebecephalus neomexicanus Tuthill, L. D., Jour. Kans. Ent. Soc., vol. 3, p. 44, 1930.

This species was described from a single female from Belen, New Mexico. The male is like the female except the elytra are longer than the abdomen and the size is slightly smaller.

Male genitalia: Valve angular, broader than long; plates not as broad at base as valve, roundingly narrowed to slightly concave margins near middle, apices rounded, mesal margins diverging on outer half. Outer half of styles more or less avicephaliform, inner margin of apex much longer than outer. Aedeagus in dorsoventral view short, apex rounded with a pair of lateral retrorse processes diverging from shaft, a second pair of retrorse processes near middle of ventral margin of shaft about one fourth as long as anterior pair. Shaft in lateral view almost as broad as long. Pygofer normal without hooks.

Allotype male and 33 parallotypes from type locality, Belen, New Mexico, July 20, 1936, R. H. Beamer. The above males with nine females were taken from a short grass in the pasture from which the type female was caught.

Hebecephalus subitus n. sp.

Resembling **H. neomexicanus** Tuthill but apex of male style not avicephaliform and last ventral segment of female with a median tooth on posterior margin instead of a notch. Length, female 1.75 mm, male, 1.5 mm.

Color: Cinereous marked with fuscous. Vertex with characteristic pair of longitudinal parallel chain markings, basally with light, converging inclusions. Veins of elytra light more or less evenly bordered with fuscous. Venter mottled with fuscous.

Genitalia: Last ventral segment of female with lateral margins rounded, posterior margin shallowly excavated with median tooth on either side of which is a small notch. Male pygofer long without hooks. Valve angular; plates as wide at base as valve, suddenly narrowing on outer third to rounded apices, mesal margins sharply diverging on outer fourth. Style slender on outer third, not avicephaliform. Aedeagus in dorsoventral

view short with a pair of diverging, retrorse processes almost half as long as shaft. Another retrorse, ventral process on shaft back from apex, possibly one fourth as long as apicals, slightly bifid.

Holotype male, allotype female, Roswell, New Mexico, July 16, 1936, R. H. Beamer. In Snow Entomological Collection.

Hebecephalus merus n. sp.

Resembling **H. neomexicanus** Tuthill but distinctly smaller in size, last ventral segment of female with posterior margin convex instead of concave, male plates with apices truncate instead of rounded and four processes of aedeagus of about equal length. Length, female 2.75 mm., male 2.5 mm.

Vertex distinctly longer than width between eyes, apex sharp, less than a right angle. Elytra longer than abdomen in female, shorter in male.

Color: Cinereous throughout, marked with fuscous. Vertex with pair of comma-shaped marks either side of apex, most of disc covered by chain-like longitudinal stripes, one either side the middle. Pronotum with three pairs of more or less definite longitudinal stripes. Elytra with veins white, more or less regularly bordered with fuscous.

Genitalia: Female last ventral segment with lateral angles rounded, posterior margin with median two thirds produced and dark-colored. Male valve obtusely angular; plates about as wide at base as valve, roundingly narrowed to truncate apices. Aedeagus in dorsoventral view with a pair of retrorse, diverging apical processes, about two-thirds as long as shaft, a second retrorse pair arising on ventral margin just before tip, paralleling shaft, about as long as apicals. Styles with more or less truncate, avicephaliform apices. Pygofer normal without hooks.

Holotype male, allotype female and one male paratype,type, Faraway Ranch, Arizona, August 24, 1935, R. H. Beamer. In Snow Entomological Collection.

Hebecephalus funestus n. sp.

Resembling **H. subitus** Beamer but female with last ventral segment much longer, median tooth less acute, male plates with lateral margins evenly curved instead of abruptly narrowed on outer third, apical third of style broader and more truncate at apex and aedeagus

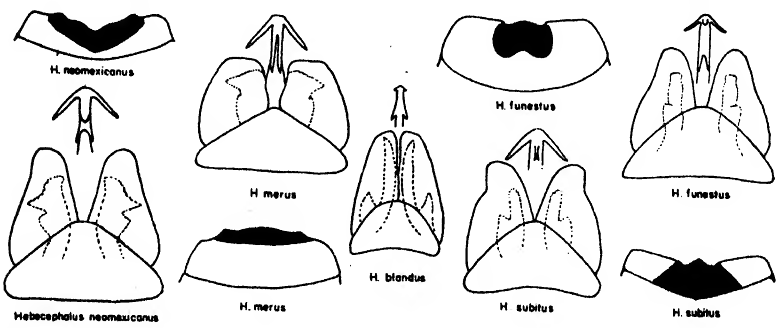
with anterior processes much shorter and narrower than posterior pair.

Vertex acute, less than a right angle, almost a third longer than width between eyes. Elytra shorter than abdomen in female, longer in male. Length, female 3 mm., male 2.25 mm.

Color: Cinereous marked with fuscous. Vertex with pair of diverging dashes at apex, sometimes connected with longitudinal chain marks. Disc of vertex mostly occupied by a pair of chain-like longitudinal marks with oblong light inclusion at their base. Pronotum with a semblance of six longitudinal stripes. Veins of elytra white, fairly regularly bordered with fuscous.

Genitalia: Female last ventral segment twice as long as penultimate, lateral angles broadly rounded, posterior margin slightly excavated to a broad, shallow, median notch which in turn has a broad slightly extended median prominence. Valve of male angular; plates about as broad at base as valve, lateral margins sinuately narrowed to bluntly rounded apices; styles abruptly narrowed on outer third to about two-thirds their width, almost parellel sided to blunt apices; aedeagus in dorsoventral view with two pairs of processes, anterior pair retrorse, about twice as long as width of shaft and diverging from it at about a 45 degree angle, posterior pair arising on ventral side of shaft just back of canal opening, running parallel with shaft for about two thirds its length, diverging from the shaft on their outer third and from each other on their outer fourth, much heavier and at least twice as long as anterior pair.

Holotype male, allotype female, 11 male and 10 female paratypes, Grady, New Mexico, July 16, 1936. R. H. Beamer. Types in Snow Entomological Collection.



A NEW POTAMOBATES FROM MEXICO (HEMIPTERA-GERRIDAE)

H. B. HUNGERFORD, Lawrence, Kansas*

In 1898 Champion described **Potamobates bidentatus** (1) and this remained for thirty years the only known Mexican species. In 1928 Drake and Harris described a species from Montzoranog, Vera Cruz, which they named **P. osborni.** (2) During the past summer Mr. Henry D. Thomas collected a third species in Mexico which is new to science.

Potamobates thomasi n. sp.

Size: Length of winged forms, both sexes, 14 33 mm.; length of wingless forms, both sexes, 13.3 mm. The females a little plumper than the males and both sexes displaying the same small variations above and below the measurements given.

Color: Body black above with shining metallic lustre. The apterous forms conspicuously striped with light brown or old ivory. Venter pale. Head black above with broad longitudinal light brown stripe between the eyes, this stripe somewhat constricted before the middle and shallowly to deeply concave on its anterior end; antennae and two distal segments of beak black; in the winged forms the anterior lobe of pronotum is marked by a light brown median longitudinal stripe and the posterior lobe is margined on sides and distal end by a band of same color, hemelytra dark brown with darker veins. In the wingless forms there is a median longitudinal light brown band on the pro, meso and metanotum followed by a row of linear spots on abdominal tergites to and including basal half of first genital segment. The mesonotum has an additional band on either side of the median one and the connexivum is margined with a continuous band of the same light color. The sides of the thorax and abdomen are covered with a silvery pubescense over black. Underside of head, thorax, abdomen, acetabula, coxae and trochanters old ivory, except for a black longitudinal streak on mesoacetabula. Legs black except anterior femora which are ivory above with a longitudinal black stripe and the under side of basal half of meso femora may be ivory to brown.

*Contribution from the Department of Entomology, University of Kansas.

Structural Characteristics: Antennal formula of male holotype: 1st: 2nd: 3rd: 4th:: 15: 5.5 : 4.3 : 5; of allotype 14.3 : 5 : 3.7: 5.1. The first antennal segment distinctly longer than width of head through the eyes. Pronotum of wingless male shorter than the head. Posterior lobe of pronotum in winged form without median longitudinal carina, except faintly on anterior half. Mesonotum of wingless male a little less than three times as long as the pronotum measured on dorsal line. Front femora, more or less cylindrical, less incrassate than in some species and provided, ventrally near distal end with a peg-like elevation. Front tarsus about one-fourth length of tibia. First tarsal segment about one-third as long as the second. Formula for intermediate leg of male:—femur: tibia : tarsus: : 20 : 12.5 : 9. First tarsal segment: second: : 7:2. Formula for posterior leg of male:—femur: tibia: tarsus:: 20.6 : 13 : 2.6. The last abdominal tergite of the male slightly longer than the one in front of it. The connexivum of the male bluntly produced behind. The connexivum of the female produced into a sharp pointed process covering two-thirds of the first genital. The connexiva of the wingless females are erect and converge caudally, their sharp pointed tips nearly continguous. The first genital segment of the male measured on the median dorsal line no longer than the last abdominal tergite, the second genital a little shorter, its basal part produced ventrally on the left side and ending in a triangular tooth or process. In the male the caudal margin of the last ventral abdominal segment is doubly emarginate. The first genital neither longitudinally grooved beneath nor modified on its posterior margin.

In the female the genital segments are symetrical, but the rear margin of the last ventral abdominal segment is produced into two stout processes, one at each caudo-ventral angle.

Location of types: Holotype, allotype, holomorphotype, allomorphotype and nine paratypes in the Frances Huntington Snow Entomological Museum, University of Kansas.

This species described from three winged specimens (one male and two females) and ten wingless specimens (five males and five females) labeled "El Sabino, Uruapan, Michoacan, Mexico, July 25, 1936. H. D. Thomas."

Comparative notes: This interesting species, while having the general facies of Potamobates and running without question to this genus by the Drake and Harris (3) key on pages 181-182 of their "Gerrinae of the Western Hemisphere" nevertheless has a closer affinity to Cylindrostethus Fieb. than any other new world species of Potamobates known to date. Its relation to Cylindrostethus is shown by the more elongate and more evenly segmented abdomen and by the relatively much smaller genital segments in the male. Its general color pattern, its longer beak, its broad somewhat flattened mesothorax, its middle and hind femora surpassing the abdomen by half their length and the asymentrical structure of the second genital segment of the male are typically Potamobates in character. **Potamobates thomasi** while the largest species so far described appears to be more nearly related to **Potamobates horvathi** Esaki and **Potamobates unidentata** Champion than to any of the others, but unlike them in lacking a projection from the rear margin of the first genital segment of the male.

Literature Cited:

1. Champion. Biol. Centr.-Amer. Rhynch. II, pp. 155-156, 1898.
2. Drake and Harris. Proc. Biol. Soc. Wash., XLI, p. 25, 1928.
3. Drake and Harris. Annals of Carnegie Museum, XXIII, pp. 181-182 and 224-225, 1934.

NOTICE.

The Thirteenth Annual Meeting of the Kansas Entomological Society will be held April 3, 1937, in Fairchild Hall, Kansas State College, Manhattan, Kansas, in Room No. 52, beginning at 10 A. M.

A NEW SPECIES OF PHYLLOPHAGA AND NOTES ON ANOTHER SCARABAEID (COLEOPTERA)

MILTON W. SANDERSON*

Phyllophaga (Phytalus) omani n. sp

Length, 14 mm.; width, 6 mm.

The present species, according to Horn's key (Trans. Am. Ent. Soc., XII, 1895, p. 119) would come out near **cephalicus** Horn. In Saylor's table of the species of this group, to appear shortly, it runs to **georgianus** Horn. to which it is evidently more closely related.

Form elongate, cylindrical, but little wider behind. Color yellow-testaceous, the head piceous.. Surface shining.

Antennae 9-segmented, the club as long as the entire stem, nearly uniformly colored as the remainder of body. Clypeus, and entire head, strongly transverse, the clypeus more than three times wider than long, rather deeply emarginate and excavated with the margin moderately reflexed. Fronto-clypeal suture lightly impressed. Front and clypeus moderately and not closely punctured, the punctures generally separated from one to several times their own diameters.

Pronotum moderately, rather unevenly punctured, the punctures closer along the anterior and posterior margins. Pronotum nearly twice as wide as long; sides sub-parallel in basal half, widest at middle, then gradually rounded to apex which is considerably narrower than at base. An indistinct fuscous spot on each side near rounded lateral margins. Basal marginal line distinct at sides.

Elytra 10 mm. in length, widest near middle. Punctures of elytra of nearly the same size as those on the pronotum, and irregular; a little rugose near the suture. Sutural costae distinct with an irregular row of punctures along each from base to apex. Discal costae obsolete. Marginal hairs entirely absent.

Pygidium rather strongly convex, nearly four-fifths as long as wide, finely and evenly punctured with a few short stiff hairs at apex; the apex evenly rounded. Entire upper surface glabrous.

Elevated portion of prosternum behind front coxae

*Contribution from Dept. of Entomology, University of Kansas.

very prominent, rather narrow and broadly emarginate at apex.

Abdomen finely punctured from side to side. the punctures becoming obsolete on the meson. Abdomen perceptibly flattened at middle and with a vague longitudinal impression on segments three and four. Pubescence nearly absent except on the penultimate segment which has an irregular transverse row of erect hairs on either side of middle; otherwise this segment is unmodified. Last abdominal segment slightly excavated at middle and with a small punctate elevation on each side; a row of erect hairs extending from each elevation to side of segment.

Posterior tibiae with one spur fixed and very short, the inner slender and a little longer than the first tarsal segment. The upper portion of claw nearly as wide at base as lower and distinctly longer. Claws very finely and longitudinally striate, the striae close and generally following the curve of claw. Lower margin of claws very finely and minutely irregularly crenulate.

Holotype, male, Burnsville, Ala., July 20, 1930, P. W. Oman, from which the above description is drawn. **Allotype,** female, Prattsburg, Ga., 7-24-30, R. H. Beamer, collected at light. I have associated the two sexes for they agree perfectly in the puncturation of the scutellum, the longer lower tooth of claw, and the crenulate lower margin of claw. The female has the antennae 9-segmented, the club a little shorter than the funicle. Both spurs of hind tibiae free. Mesosternum sparsely punctured and with a few very short hairs. Abdomen slightly flattened at middle and with a few moderately coarse punctures along the sides; penultimate segment irregularly punctured at sides and on posterior half. Pygidium transverse and evenly punctured. Body behind a little more robust than in the male.

This insect has a strong superficial resemblance to **Phyllophaga gracilis** (Burm.) by its strongly transverse head and pronotum. It is easily separated from **georgianus** Horn (of the Phytalus Group) as follows: the scutellum is only distinctly punctured along the sides; the lower tooth of the claw is fully two-thirds that of the upper; and the fixed spur of the hind tibia is directly continuous with the tibial margin. In **georgianus** the

scutellum is evenly punctured over the entire surface; the lower tooth of claw is not more than one-half the length of the upper; and the entire apical margin of posterior tibia is distinct. Comparison of the male genitalia shows this organ to be much less stout than that of **georgianus** although of the same general shape. There is also a similarity to that of **glaberrima** (Blanch.). Indeed all three species have the elevations on the last abdominal segment as described for **omani.** However, **glaberrima** has the tooth of the claw very small and intramedian.

Leptohoplia testaceipennis Saylor

1935 Pan-Pacific Entomologist, XI, 3, pp. 132-134.

The new genus and species, **Leptohoplia testaceipennis** Saylor, was described from three males from Imperial County, California, collected during June and July, 1912, by J. C. Bridwell. At the time this description appeared, I had in manuscript a description of this species. Since Saylor had but one sex of the species, the female is here described and designated as **allotype.**

The female agrees in all essential characters with the male except as follows:

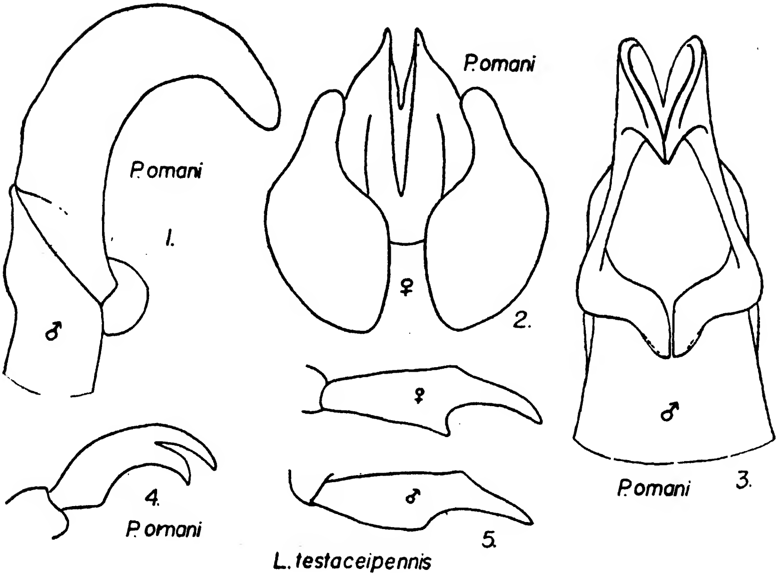
The 3-segmented antennal club of the female is but slightly shorter than the stem, whereas that of the male is one-third longer than the stem. The posterior tooth of anterior tibia of female is acute and considerably less than right angled, while that of the male is blunt. The first posterior tarsal segment of the female is distinctly shorter than the width of posterior tibia at apex. In the male, this tarsal segment is distinctly longer than the width of tibia. A further comparison shows that the posterior tibiae and tarsi of the female are proportionately broader and shorter than those of the male.

Allotype female, Holtville, Calif., July 2, 1929, R. H. Beamer. Three additional males collected with the female.

Types of the above species deposited in the Snow Collection.

Explanation of Drawings

1. Right lateral view of aedeagus.
2. Ventral view of pubic process of female.
3. Ventral view of aedeagus.
4. Tarsal claw.
5. Anterior tibiae of male and female.



THE GENUS EUPHALERUS IN AMERICA NORTH OF MEXICO (PSYLLIDAE: HOMOPTERA)

L. D. TUTHILL, Iowa State College, Ames, Iowa

The Psyllidae (Chermidae) upon which this paper is based were very kindly loaned to the writer from the Snow Entomological Collection at the University of Kansas by Dr. R. H. Beamer. The genus **Euphalerus** is represented in North America north of Mexico by seven species, four of which are described for the first time in this paper. The type of the genus **E. nidifex** Schwarz is included although it has not been recorded from the mainland of North America.

Key to North American Species of Euphalerus.

1. Color reddish brown, including wings, male forceps not simple .... 2.

Color not as above (mostly greenish in appearance); male forceps simple and acute at apex ...... 3.

2. Large species (3.75 mm. in length), genal cones longer than vertex; male forceps with a heavy, slightly T shaped tooth medially at apex .... **adustus** n. sp.
Small species (2.50 mm. in length), genal cones shorter than vertex, male forceps appearing folded .... **tantillus** n. sp.

3. Entire body including wings speckled with brown or black dots and spots .... **nidifex** Schwarz.
Body not speckled with brown or black spots ...... 4.

4. Forewings rounded at apex .... 5.
Forewings distinctly rhomboidal..**propinquus** Crawf.

5. Wings with one or more prominent maculae ...... 6.
Wings not maculated .... **rugipennis** Crawf.

6. Veins of forewings extremely prominent, strongly raised, distinctly marked with rather regularly spaced white spots .... **jugovenosus** n. sp.
Veins of forewings normal, without white spots .... 7.

7. Forewings covered with a white, waxy powder, with a single prominent black spot at extremity of clavus .... **beameri** n. sp.
Forewings hyaline, whole apical margin more or less maculated .... **vermiculosus** Crawf.

Euphalerus adustus n. sp.

Resembling **E. rugipennis** Crawford but a larger, reddish species without the characteristic white spots; wings less rugose. Length to tip of folded wings 3.75 mm.

Color. Uniformly yellowish red, some white vermiculations on head and thoracic dorsum. Wings brown, apical portion faintly cloudy. Abdomen sometimes greenish.

Structure. Body large, finely punctate. Vertex twice as wide as long, flat, smooth, pubescent on anterior margin. Antennae one and one half times as long as width of head, genal cones large, as long as vertex, rounded, swollen in appearance, rather acute, prominently pubescent, thorax strongly arched. Forewings rugose, about two and one half times as long as wide, pterostigma large, vein Rs sinuate. Abdomen large, extending almost to apex of wings.

Genitalia. Male proctiger large, typical in shape.

Forceps large, almost as long as proctiger, straight and very broad in either lateral or caudal view; anterior margins heavily pubescent to roundly truncate apex; postero-medial margins produced into heavy, slightly bifid, somewhat T shaped teeth, extending barely beyond apex. Female genital segment about half as long as rest of abdomen, evenly narrowed to rather acute apex.

Holotype male, allotype female, and one female paratype, Weber Canyon, Utah, July 4, 1931, R. H. Beamer; one female paratype Maybell, Colorado, June 30, 1931, R. H. Beamer; one male paratype Fks. Logan Can., Utah, Aug. 21, 1934, C. F. Smith and T. O. Thatcher.

Holotype, allotype and one female paratype in Snow Entomological Collection, Univ. of Kansas; one female paratype in author's collection; male paratype in U. S. N. M., Washington, D. C.

Euphalerus tantillus n. sp.

Resembling **E. adustus** n. sp., but much smaller and with distinctive genitalia, the female genital segment subglobose at base with a styliform prolongation, the male forceps folded in appearance. Length to tip of folded wings 2.50 mm.

Color. Brownish red with some indistinct, lighter markings on head and thorax. Forewings reddish fumate.

Structure. Head large, strongly deflexed. Vertex twice as wide as long, with prominent impression on each side, somewhat bulging in front, very slightly pubescent on anterior margin. Antennae slightly longer than width of head. Genal cones moderately large, two thirds as long as vertex, quite conical in shape, with sparse, short pubesence. Forewings slightly more than twice as long as wide, rugose, pterostigma small.

Genitalia. Male proctiger large, heavy, parallel sided to truncate apex; forceps about two thirds as long as proctiger, in lateral view broad and much enlarged at apices, in caudal view very broad at base, sharply narrowed and moderately broad to apices, medio-posterior margins produced anteriorly to give an appearance of a folded structure which appears bifurcate from dorsal view. Female genital segment slightly longer than rest of abdomen, very large at base, suddenly narrowed to a slender, acuminate process, with very long prominent

hairs on basal portion.

Holotype male, allotype female, six male and three female paratypes, Salt Lake City, Utah, July 3, 1931, R. H. Beamer.

Holotype, allotype and paratypes in Snow Entomological Collection, University of Kansas; one pair of paratypes in author's collection.

Euphalerus nidifex Schwarz

Euphalerus nidifex Schwarz, Proc. Ent. Soc. Wash., VI, p. 153, 1904

This West Indian species is greenish white, covered over the entire surface, including legs and wings, with brown or black spots. In this it differs from all species found in the United States, but resembles **E. championi** and other Central American species. I have not seen any specimens of this species.

Euphalerus vermiculosus Crawford.

Euphalerus vermiculosus Crawford, U. S. N. M. Bull. 85, p. 121, 1914.

This insect is quite typical of a number of species found in the western United States. Its general color is greenish white to yellowish white, the thorax darker. The wings are semihyaline, fumate in apical part, the apical margin alternately black and white. The forceps of the male are slender, with a sharp, black hook at the apex, the proctiger is simple. The female genital segment is short, heavy and acute at apex.

Specimens have been examined from Siskyou National Forest, Dunsmuir, Dales and Eureka, California; Hood River and Biggs, Oregon; Haugan, Montana.

Euphalerus propinquus Crawford

Euphalerus propinquus Crawford, U. S. N. M. Bull. 85, p. 122, 1914.

This species may readily be distinguished from all other members of the genus by the rhomboidal shape of the wings. Its color is very much like that of **vermiculosus.**

Specimens are at hand from the Huachuaca and Chiricahua Mountains of Arizona.

Euphalerus rugipennis Crawford

Euphalerus rugipennis Crawford, U. S. N. M. Bull. 85, p. 120, 1914.

(To be continued in Vol. 10, No. 3)

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Vol. 10, No. 3. July, 1937.

THE GENUS EUPHALERUS IN AMERICA NORTH OF MEXICO (PSYLLIDAE: HOMOPTERA)

L. D. TUTHILL, Iowa State College, Ames, Iowa

(Concluded from Vol. 10, No. 2)

This small white spotted species was described as yellowish orange to reddish brown in general color. The specimens at hand are green with the exception of three specimens from San Diego County, California, which are partially red, principally on the thorax.

Examples from the Santa Rita Mountains, Arizona, were compared with the type from Oracle, Arizona, in the U. S. N. M. by Mr. P. W. Oman. In addition the writer has specimens from Yarnell, Arizona; Upper Lake, Big Bear Lake, Lockwood, Dales, Anza, San Diego, and Siskyou National Forest, California; Grants Pass and Kerby, Oregon.

Euphalerus beameri n. sp.

Resembling **E. vermiculosus** Crawford, in size and general appearance but forewings white to clear with a single black spot at apex of clavus; genal cones larger, broader and less conical. Length to tip of folded wings 3.00—3.25 mm.

Color. General body color red to whitish red. Vertex and genal cones white, with more or less red vermiculation. Thorax and legs reddish. Forewings typically covered with a white bloom, with a prominent black spot at extremity of clavus. Abdomen green.

Structure. Head large, deflexed, vertex flat, slightly pubescent. Genal cones large, rather flat contiguous basally, broadened slightly below juncture with vertex, conspicuously pubescent, very coarsely rugose. Antennae one fourth longer than width of head. Thorax strongly arched. Forewings twice as long as broad, rugose, the pterostigma moderately large.

Genitalia. Male very similar to **vermiculosus.** Proctiger somewhat sinuate on posterior margin, forceps longer, almost as long as proctiger, with large tooth on apex. Female genital segment larger than in **vermiculosus,** almost as long as rest of abdomen, stout, dorsal valve slightly longer than ventral.

Holotype male, allotype female, three male and twelve female paratypes, Big Bear Lake, California, July 26, 1932. Other paratypes as follows: twenty-one males and twenty-two females, San Jacinto Mountains, Calif-

ornia, July 21, 1929, R. H. Beamer; two males and two females, San Diego County, California, July 4, 1929, R. H. Beamer; two males and four females, Laguna Mountains, California, July 6, 1929, R. H. Beamer; one male San Diego County, California, July 4, 1929, L. D. Anderson; one female, Campo, California, August 10, 1935, R. H. Beamer.

Holotype, allotype and paratypes in Snow Entomological Collection, University of Kansas; three pairs of paratypes in author's collection.

This species is named in honor of Dr. R. H. Beamer of the University of Kansas.

Euphalerus jugovenosus n. sp.

Resembling **E. beameri** n. sp., but smaller, veins of forewing much more prominent; color markings very different. Length to tip of folded wings 2.50-3.00 mm.

Color. Head, pronotum and praescutum white, with more or less vermiculate red markings; remainder of thorax dark red; legs somewhat lighter. Forewings hyaline except apex dark through cell Cu, latter black, apical margin alternately black and white; veins with rather regular opaque whitish areas and irregular red spots. Abdomen green, male genitalia and tip of female genital segment red.

Structure. Vertex twice as wide as long, posterior margin almost straight, with large discal impressions. Genal cones large, shorter than vertex, very broad, somewhat divergent, moderately pubescent. Thorax very strongly arched. Forewings short, about twice as long as broad, veins extremely prominent, the pterostigma moderately large.

Genitalia. Male genital segment moderately large. Proctiger large, much produced on posterior margin into a broad lobe, narrowing to truncate apex. Forceps slender, straight, shorter than proctiger, evenly narrowed to large black medially projecting apical teeth. Female genital segment about as long as rest of abdomen, stout, quickly narrowed to acute apex; dorsal valve longer than ventral and very sharp and upcurved at tip.

Holotype male, allotype female, three male and four female paratypes, Lockwood, California, July 24, 1935, R. H. Beamer; one female paratype, Monterey, California, July 22, 1935, Jack Beamer.

Holotype, allotype and paratypes in Snow Entomological Collection, University of Kansas. One pair of paratypes in author's collection.

A GRASSHOPPER SURVEY FOR EASTERN KANSAS, 1936.

LAURENCE C. WOODRUFF, Lawrence, Kansas*

The season of 1936 was one of serious grasshopper injury in Kansas and throughout much of the plains area; by far the worst that has occurred for many years. Added to the effects of an extensive and prolonged drought, the resulting losses were all the more apparent. Few varieties of plants were immune from attack and many, such as the evergreens and fruit trees which suffered girdling of the twigs and branches, in addition to defoliation, will be years in recovering. "Old-timers" availed themselves of the opportunity to reminisce on the locust invasion of the last century but in most such comparisons the existing conditions fell far short of the past. Obviously something was lacking. Extensive flights or migrations which caused so much consternation among the early settlers of the plains region were not observed during the season of 1936. Mass movements of hoppers from one field to another were common but these were mostly of the saltatorial type and, at best, involved a comparatively small area. The complexion of the locust population was apparently composed simply of a greater quantity of the usually abundant species. But casual observations are seldom reliable and it was to establish the identity and relative proportions of the injurious species that this survey was conceived.

Four type habitats were selected as typical of situations commonly inhabited by grasshoppers with the idea in mind that collections of specimens from these would give a characteristic section of the hopper population of this region. The areas chosen were an alfalfa field, a corn field, a weed patch, and a field of prairie grasses.

The field of alfalfa was of about five acres in extent, situated upon a slight southern slope and bounded upon two sides by pasture land. A third side was formed by the bed of a meandering creek with wooded banks; the fourth by a hay field of gamma grass. The latter had been cut during June and because of the heat and drought was practically bare during the entire period of observation.

This same hay field formed the northern boundary

*Contribution from Department of Entomology, University of Kansas

of the ten acre corn field selected and a continuation of the wooded creek defined the western limits. To the east and across a road lay an unused pasture. A large garden area devoted to a variety of crops was located to the south.

The weed patch was simply that—with no adornments. An area of about one-half acre of very heavy soil situated in the center of a pasture had been fenced off and neglected because of poor drainage. This plot would normally have been exceedingly wet, but the soil was baked hard and full of cracks throughout the summer. The predominant plants were ragweed, white clover, sunflowers, and wild lettuce.

On the south slope of the University of Kansas campus there still exists a patch of virgin prairie which has been preserved in its original condition with no attempted plant introduction. Undoubtedly, some of the many plants which have followed man into this region have crept in, but so far as is known the only attention ever given the tract is an occasional burning over. This area should be representative of the original environment of the grasshoppers in the plains states and was selected as one of the four type habitats for this reason. The native grasses of this tract are coarse in texture, dry and brittle as compared with other grasses found in the majority of the pastures or hayfields. Owing to the facts that this preserve was uncut and that no grazing was permitted, a lush growth forming a knee-deep mat covered the ground during the entire summer. The grasses growing here were mostly blue-stems but several other varieties as well as flowering plants were present. When one considers the large number of grasses which have become abundant in this region since the coming of the white man, it seems highly improbable that the original identity of virgin prairie has been maintained. Nevertheless, collections from such a habitat give an interesting and enlightening comparison with those from cultivated regions.

Collections were made thrice weekly in the four plots, beginning July 1st and continuing until August 21st. In each area one hundred sweeps with a twelve inch net were made at a fast walk through the plant growth. Undoubtedly such a procedure was at fault in that many 'hoppers in the direct path escaped, but at least

the records for all plots were comparable. The material was brought to the laboratory and classified by comparison with specimens in the Snow Collection previously identified by Morgan Hebard (1931). Many specimens were probably misidentified, for in the case of some closely related species only minute differences were discernible, but considering the volume of material handled a few misnamed individuals would not change the picture perceptibly. The type of information desired did not warrant the burdening of a specialist with the onerous task of determining all of the collections. The worst difficulty was encountered in the separation of **Melanoplus femur-rubrum** and **Melanoplus mexicanus.** The males of these two species are fairly distinct but I never was able to distinguish the females. To avoid this impossible situation, the females of the two species for a particular sample were divided in the same proportion as the males had occurred. This procedure is unquestionably subject to great error, but the only plausible answer to the problem of handling such a mass of material.

Results of Collections

During the period covered by these observations, a total of 9824 individuals were collected, of which 4227 were nymphs. For the latter no attempt at classification was made, leaving a total of 5597 identified specimens upon which the records here described are based. The distribution of this total of nearly six thousand individuals within the four plots under observation was as follows:

Alfalfa	3382	60.5%	of total
Corn	718	12.8%	of total
Prairie	759	13.5%	of total
Weed patch	738	13.2%	of total

The larger total gathered from the alfalfa field might be explained in part by the fact that sweeping could be done with greater facility in a ground coverage of this type than was possible in either the corn field or the weed patch where the plants were shoulder high. The same argument cannot be applied, however, to explain the difference between the alfalfa field and the area of prairie grass, and the true answer probably lies in the more succulent nature of the former crop.

The percentile distribution of species in the total col-

lections from all plots are here given:

Species	No.	% of Total
Melanoplus femur-rubrum (DeGeer)	2867	51.5
Melanoplus differentialis (Thomas)	738	13.0
Melanoplus mexicanus (Saussure)	656	11.5
Melanoplus bivittatus (Say)	567	10.1
Orphulella pelidna (Burmeister)	221	4.0
Orphulella speciosa (Scudder)	205	3.7
Mermiria bivittata (Serville)	175	3.1
Syrbula admirabilis (Uhler)	81	1.4
Hippiscus rugosus (Scudder)	24	0.5
Chortophaga viridifasciata (DeGeer)	21	0.4
Ageneotettix deorum (Scudder)	16	0.3
Dissosteira carolina (Linnaeus)	11	0.2
Others:	15	0.3

These include:

Melanoplus keeleri (Dodge)
Schistocerca americana (Drury)
Schistocerca lineata Scudder
Pardalophora haldemanii (Scudder)
Arphia xanthoptera (Burmeister)
Dichromorpha viridis (Scudder)
Mermiria maculipennis Bruner

The dominance of **Melanoplus femur-rubrum,** comprising fifty per cent of the total collection of adults, is perhaps the most striking item in the list but scarcely more so than the fact that the bulk (85%) of grasshoppers for eastern Kansas during 1936 was made up of four species. Curiously enough, all are members of the genus Melanoplus.

While the records of total collections are interesting, those of the individual plots appear to be more instructive. In the tables below, the principal species are listed along with their percentage of the total for each plot.

ALFALFA (Total 3382)

Melanoplus differentialis (Thomas)	7.1%
Melanoplus bivittatus (Say)	6.5%
Melanoplus femur-rubrum (DeGeer)	69.0%
Melanoplus mexicanus (Saussure)	12.7%
All others	4.7%

Melanoplus femur-rubrum shows itself to be the

outstanding alfalfa pest, a dominance even more striking when we consider the large number of individuals concerned. From observations in the field at the time the collections were being made, I gained the impression that **Melanoplus differentialis** and **Melanoplus bivittatus** were more common than the tabulated results indicate. For this reason I hesitate to give an unqualified statement as to the vastly greater importance of one over the others. This discrepancy might be explained by the fact that the larger species are more active and thus better able to avoid capture in the net. A second and somewhat more tenable solution is to be found in the definite movements of the larger species out of the alfalfa into the surrounding fields with the depletion of the available food. On the other hand, **Melanoplus femur-rubrum** maintained itself at a fairly constant level throughout the season, even after the plants become fairly well defoliated during August. I am inclined to believe that probably both of these factors were influential. Samples from the trough of a hopperdozer being used in other alfalfa fields in Douglas County contained a much greater percentage of the larger species than were found in my collections.

WEED PATCH (Total 738)	
Melanoplus differentialis (Thomas)	36.5%
Melanoplus bivittatus (Say)	26.6%
Melanoplus femur-rubrum (DeGeer)	21.0%
Melanoplus mexicanus (Saussure)	12.7%
All others	2.3%

In this series there is no dominant species, but rather four strong contenders, again the outstanding members of the genus Melanoplus. Minor species are surprisingly scarce in this area, comprising only 2.3% of the total. Likewise, few nymphs were collected among the weeds during the entire season. On the other hand, the numbers of adults increased gradually through July and held up well during August while the collections in other sections were on the wane. This is further evidence of the contention made above that the larger species were moving from the alfalfa as the season progressed. **Melanoplus femur-rubrum,** while plentiful, does not make up such a large proportion of the total here as in alfalfa.

PRAIRIE (Total 759)

Melanoplus differentialis (Thomas)	15.5%
Melanoplus bivittatus (Say)	8.8%
Melanoplus femur-rubrum (DeGeer)	3.3%
Melanoplus mexicanus (Saussure)	6.9%
Orphulella pelidna (Burmeister)	21.3%
Orphulella speciosa (Scudder)	15.2%
Mermiria bivittata (Serville)	18.5%
Syrbula admirabilis (Uhler)	6.2%
All others	4.3%

Grasshoppers apparently belie their name. At least, this seems to be true for the species which cause the bulk of injury to agriculture. Certainly they do not occur in such large proportions here among the native grasses as elsewhere. In their places among the abundant forms, we find a number of species which in the cultivated areas are rare. The scarcity of **Melanoplus femur-rubrum** is particularly striking. The prairie regions are undoubtedly the native habitat of the genera Orphulella, Mermiria, and Syrbula.

Not only were the notorious species conspicuously scarce in the prairie grasses, but the injury by those which were present was of little consequence. Seldom has serious damage by grasshoppers been reported for native grasses. The coarse texture and dry nature of these plants which fit them for existence under prairie conditions at the same time render them less palatable than more succulent and softer bodied plants. Wilbur (1936) attributes the injury to the inflorescence of grasses by locusts to a search more for water than for food.

CORN (Total 718)

Melanoplus differentialis (Thomas)	14.8%
Melanoplus bivittatus (Say)	13.6%
Melanoplus femur-rubrum (DeGeer)	33.5%
Melanoplus mexicanus (Saussure)	17.6%
Orphulella pelidna (Burmeister)	6.5%
Orphulella speciosa (Scudder)	5.0%
Mermiria bivittata (Serville)	7.4%
All others	1.6%

The inclusion in this list of several species even more characteristic of the prairie region(see above) points to

a similarity between these two areas. True, the fence-row of the corn field was composed largely of native grasses but the sweepings, although made along this side of the field, were confined to the cultivated crop. The species in question, then, while undoubtedly originating in the grass, had to be feeding or at least resting on the corn in order to be caught. **Melanoplus femur-rubrum,** here as in the alfalfa, is the leading species but not dominantly so. The same sources of error, encountered for the larger species of Melanoplus for alfalfa, undoubtedly prevailed in the corn also. As a matter of fact, the progress of migration was observed during the early part of August after the plants began to show material evidence of injury. Collections from this field were discontinued on August 14th when what was left of the crop was cut for fodder.

Discussion

Over four thousand nymphs were collected along with the adults during the season but were not identified. These immature forms comprised the chief part of the collections at first, but by the middle of July a parity had been reached and during August nymphs gradually disappeared. Quite naturally this decline was accompanied by a corresponding increase in the number of adults.

Grasshoppers have long been the worst insect menace in the prairie regions, remaining as endemic pests across the years, bursting into unusual prominence during periods of drought. The same climatic factors which foster arid conditions also are favorable to the development of these insects. The species which caused the major part of the trouble during 1936 were those generally abundant year after year. The ubiquitous red-legged locust **(Melanoplus femur-rubrum)** was especially injurious to alfalfa but by no means was it confined to this crop. For, over the countryside in general, samples always contained a high percentage of this form. **Melanoplus mexicanus** certainly did not live up to its reputation, given by Hebard and others, as our most numerous grasshopper. Although widely and fairly evenly distributed, it was the least common representative of the four notorious members of the genus Melanoplus. The migratory phase of this species (variety **spretus**), which is responsible for much of the reputation that Kansas and other mid-western states have for devastating grasshopper invasions, was not taken in spite

of newspaper stories to the effect that this greatly feared insect had returned after many years of absence. Of the two larger species of the genus, **Melanoplus differentialis** continues to be the more abundant and undoubtedly the more injurious, but its margin over **Melanoplus bivittatus** is not great and the indications are that the latter is on the increase. Irrespective of my own collections, I cannot but feel that **Melanoplus differentialis** and **Melanoplus bivitatus** were more prevalent than indicated by the actual counts. Casual but repeated observations in grasslands, field crops, orchards, and gardens lead me to this belief. Of course, **Melanoplus femur-rubrum** shows up so strongly because of its preponderance in alfalfa, but the evidence of observation and of samples from the trough of a hopperdozzer indicate that the more robust species, especially **M. differentialis,** were far more abundant than shown by the results of net-sweeping. This apparent discrepancy may be accounted for in two ways: first, because the larger forms perhaps are more wary and avoid capture in the net; second, because they moved out of the cultivated fields as these became defoliated during the progress of the season while **Melanoplus femur-rubrum** showed little tendency toward migration.

A slight but definite diminution in the mass of the collections occurred toward the end of the period covered by these observations. This was due, in part, to the fact that the corn plot was cut for silage on August 14, but the crop already had been seriously injured by that time and concerted movements of hoppers from the field had been noted. The alfalfa field also had reached the stage, during the first half of August, where there was little left in the way of food but the stems of plants. Even the weed patch, which at first had been the focus of migrations from other fields, was beginning to show the effects of continued feeding. Naturally, with the decline of the crops under observation, the hoppers moved into locations offering more succulent food.

Migrations, such as those noted in the other three plots, were not observed for the grasshoppers infesting the prairie grasses. Here, the collections maintained a fairly constant level throughout the summer, so that, while there was no evident movement away from that quarter, neither was there any great influx. On the other hand, the individual collections in this plot never reached

the peak of the others and consequently the season's total was scarcely larger. An almost entirely distinct fauna was characteristic of this area. The members of the genus Melanoplus, so dominant elsewhere, were reduced to an equal, or even lesser, footing with four species of the slant-face group. Minor forms, which were not recorded individually, also occurred more often among the native grasses. Of all the plots under observation, the prairie region showed less indication of serious injury at the end of the season, a condition probably accountable to a more complete ground coverage and a less succulent food.

A distinct similarity, with respect to the kinds of grasshoppers involved, was evident between the prairie and corn plots. While not so abundant in the corn, many species were held in common by the two places, species not found to any extent in the alfalfa or weeds.

Summary

Serious grasshopper injury occurred in Kansas, as elsewhere in the plains region, during the season of 1936. For the purpose of determining these grasshopper populations, repeated collections were made in typical habitats and the relative abundance of nineteen species recorded.

A fairly distinct fauna was found to be characteristic of the prairie grasses as compared with those of the cultivated crops. Actual injury to the native grasses was slight.

The principal injurious species all belonged to the genus Melanoplus. **Melanoplus mexicanus** was of only minor importance while its migratory phase, **spretus,** was not observed. **Melanoplus femur-rubrum** was the outstanding pest of alfalfa, but also abundant elsewhere. **Melanoplus differentialis** and **Melanoplus bivittatus** were slightly less abundant than the red-legged locust, but due to their larger size and more voracious feeding, were probably of nearly equal importance.

Literature Cited

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Grasshopper injury to the inflorescence of pasture grasses.
Jour. Kans. Ent. Soc., 9, 1-12.

MINUTES OF THE THIRTEENTH ANNUAL MEETING OF THE KANSAS ENTOMOLOGICAL SOCIETY

Kansas State College,
Manhattan, Kansas
April 3, 1937

Business Meeting

President D. A. Wilbur called the meeting to order at 10:35 a. m. in room 52, Fairchild Hall.

The minutes of the twelfth annual meeting were read and approved.

Reports of Officers.

The secretary reported that the Society has 117 subscribers distributed in England, Canada, Germany, Peru, China, and the United States.

The treasurer's report was read and approved as follows: The Society has as assets three United States Savings Bonds $487.50, these mature in ten years to the value of $650; in the checking account of the treasurer, $248.45; current accounts receivable $46.03; old accounts receivable (H. M. Hefley) $4.78; current bills $67.63 in connection with printing Volume 10, No. 2. The net assets of the Society are $786.76 plus $1.50 cash plus $11.08 due from the printer for overpayment, less the liabilities of $67.63; or a net total assets of $731.81.

The secretary-treasurer stated that he had served for ten years and that he desired to have someone else elected to the office.

Report of editor: P. B. Lawson made a comment on the type of papers which have been published in the past few years. He stated that the type of papers should be selected to fit closer the purpose of the Journal. The subject of modifying the price of separates was brought forth due to the comments of authors of papers. R. L. Parker made the comment that the scope of the Journal had been widened to the Trans-Mississippi area and that the primary function was the publication of insect lists, taxonomic, and biological papers. R. H. Painter made the comment that the published material be more or less confined to the Great Plains Area. H. B. Hungerford stated that the Journal should be maintained in a varied nature and should be open to the general amateur as well as to the professional in the science. The price of separates should remain the same and not be lowered. E. G. Kelly suggested that he would like to see some issue

in each volume devoted to economic entomology. R. L. Parker stated that this was contrary to the policy of the publication committee since the idea in view was to maintain each issue of a varied nature in so far as possible.

Reports of Standing Committees:

Wild Life. No report.

Appointment of Committees.

Nominations committee.
Kathleen Doering
H. R. Bryson
P. B. Lawson

Resolutions Committee.
H. H. Walkden
Milton W. Sanderson
B. A. Osterberger

Auditing Committee.
N. E. Good
L. C. Woodruff

Old Business. None.

New Business.

The matter of junior membership in the Kansas Entomological Society was brought up and a letter from Max Kisliuk, Jr. of the New York Entomological Society was read in regard to this matter. Hazel E. Branch, chairman of the Junior Academy of Science, commented upon the Junior Academy of Science groups stating that groups were formed in high schools and paid individual dues. The motion was made and carried that the matter of Junior membership in connection with entomology be left with the Junior Academy of Science.

President D. A. Wilbur at this time announced that a sound film "Hidden Enemies" would be shown by W. A. Talbott of the Underhill Terminix Company. This was the 101st presentation of this film. Following the showing of this film President Wilbur announced that the meeting and presentation of papers would carry through until 12:30 p. m. The following papers were presented:

1. "A Grasshopper survey for eastern Kansas, 1936." Laurence C. Woodruff, U. of K., Lawrence.
2. "Orthoptera of the prairie." Don B. Whelan, U. of Nebraska, Lincoln.
3. "Differential injury to corn and sorghums by grasshoppers". A. M. Brunson and R. H. Painter, Kan.

Agr. Exp. Sta.

4. "The need of further research work on the biology and control of grasshoppers." George A. Dean, Kan. Agr. Exp. Sta.

Discussion: L. C. Woodruff stated that grasshoppers did not feed when the temperature was above 90 degrees F. and that during certain periods of the summer it was evident that grasshoppers did not feed to any great extent unless it was about two or three o'clock in the morning when the temperature dropped below 90 degree F. D. A. Wilbur stated that the usual temperature range for feeding by grasshoppers was from 70 to 85 degrees F.

5. "A curious beetle from Australia." Milton W. Sanderson, U. of K., Lawrence.

This presentation dealt with the beetle living in the posterior alimintary canal of Kangaroos.

6. "The genus **Novellina.**" Dale Lindsey, U. of K., Lawrence.

7. "The Rate of regeneration in the cockroach." Lois Seaman, U. of K., Lawrence.

Adjourned 12:30 p. m.
Reconvened 2:10 p. m.

8. "Some parasites of Saturniid pupae." Louis J. Lipovsky, U. of K., Lawrence.

9. "Notes on an interesting food habit of false wire worm adults." H. H. Walkden, Bur. Ent. and Plant Quar., U. S. D. A., Manhattan, and H. R. Bryson, Kan, Agr. Exp. Sta., Manhattan.

10. "Attempts to infect termites with a pathogenic fungus of the genus **Empusa.**" C. R. Rogers, K. S. C., Manhattan.

11. "Some aspects of the physiological chemistry of insects." H. D. Thomas, U. of K., Lawrence.

12. "Sixth insect population summary of Kansas covering the year, 1936." Roger C. Smith, and E. G. Kelly, K. S. C., Manhattan.

13. "The English sparrow (**Passer domesticus** L.) as a means of transmitting ectoparasites to chicken pens." Wm. L. Hoyle, K. S. C., Manhattan.

14. Some leafhoppers of the short-grass region of the U. S." Raymond H. Beamer, U. of K., Lawrence.

15. "The Control of the flat-headed borer with paradichlorobenzene paraffin mixture. (**Chrysobothris femorata** Fab., Buprestidae, Coleoptera)." L. M. Copen-

hafer, Kan. Highway Commission.

16. "Two new species of the genus **Potamobates.**" H. B. Hungerford, U. of K., Lawrence.

17. "Biological studies on mosquitoes of the genus Psorophora." H. H. Schwardt, K. S. C., Manhattan.

18. "Notes on the mosquitoes of Kansas." Miss N. A. Demoss, K. S. C., Manhattan.

19. Omitted "A specimen file of insect injuries to Kansas grasses." D. A. Wilbur, Kan. Agri. Exp. Sta., Manhattan.

20. "The biology and control of the redbud leafroller (**Gelechia cercerisella** Chem., Gelechidae, Lepidoptera)" R. L. Parker, Kan. Agr. Exp. Sta., Manhattan.

21. "The architecture of the generalized Insect." Philip Leverault, U. of K., Lawrence.

22. "The head of **Ramphocorixa acuminata** (Uhler)." Melvin E. Griffith, U. of K., Lawrence.

23. "Differential resistance to chinch bug attack in certain strains of wheat." Elmer T. Jones, Bur. of Ent., and Plant Quar., U. S. D. A., Manhattan.

24. "Some notes on **Anacentrinus subnudus** (Curculionidae, Coleoptera)." B. A. Osterberger and M. A. Christian, La., Agr. Exp. Sta., Baton Rouge, Louisiana.

Final business.

Reports of Committees.

Auditing Committee:

These accounts (treasurer's accounts for 1936) have been audited this 3rd day of April, 1937, and found to be in order.

(Signed) L. C. Woodruff. N. E. Good

The motion was made and carried to accept this report of the auditing committee.

The auditing committee made a report at the suggestion of the secretary-treasurer that a safety lock box be obtained in which to deposit valuable papers of the Society. A motion was made and carried that the secretary-treasurer rent a safety lock box.

Resolutions Committee.

1. Be it resolved: That the Kansas Entomological Society express to the officials and to the Department of Entomology at the Kansas State College, to the officers of the Kansas Academy of Science, and to the Committee on arrangements, its appreciation for the excellent facilities provided for its meeting and entertainment.

2. Be it further resolved: That this society express its appreciation to the outgoing officers for their faithful and interested leadership, to the publication committee for maintaining the high quality of the Journal, and to the retiring secretary-treasurer for the very efficient manner in which he has handled the affairs of the Society during his ten year tenure of office.

3. Be it further resolved: That the committee feels that the individual members of the Society should do all in their power to further the study of entomology among interested members of the Junior Academy of Science.

4. Be it further resolved: That in as much as the attendance of our annual meetings has greatly increased, and that the expense of entertainment may place undue financial burden on a local group, the committee is of the opinion that the policy of the Society in the future should be that each person in attendance assume his pro rata share of the expenses. In the past, the informal evening meeting have been a source of great pleasure, affording opportunity for social contact among the members, and the committee feels that these informal gatherings be continued whenever possible.

(Signed)

H. H. Walkden, Chairman
B. A. Osterberger
Milton W. Sanderson

The motion was made and carried to accept as a whole the report of the resolutions committee.

Nominations Committee.

Warren Knaus, president
L. C. Woodruff, vice-president
H. H. Walkden, secretary-treasurer.

Publications Committee.

P. B. Lawson
Warren Knaus
R. H. Painter
Dwight Isely
R. H. Beamer

(Signed)

Kathleen Doering, Chairman
H. R. Bryson
P. B. Lawson

A motion was made and carried that the report of the nominations committee be accepted.

The secretary-treasurer asked that his books be audited from January 1 through April 1, 1937, since the work of the auditing committee was only for the calendar year 1936. President D. A. Wilbur appointed N. E. Good as special auditing committee.

President D. A. Wilbur called vice-President L. C. Woodruff to the chair to preside but since there was no unfinished business the meeting was adjourned. Adjourned at 5:55 p. m.

There were 72 members and friends present from Atwood, Beloit, Emporia, Lawrence, Lindsborg, Manhattan, Sterling, Topeka, Wichita, Winfield.

In the evening a banquet and entertainment was held at the Manhattan Country Club with seventy-seven persons present.

R. L. PARKER, Secretary.

A REVIEW OF THE GENUS OSBORNELLUS IN THE UNITED STATES AND CANADA (HOMOPTERA-CICADELLIDAE)

R. H. BEAMER, Lawrence, Kansas*

This paper is an attempt to define the known species of the genus Osbornellus and name at least a part of the new forms that have been found. No little difficulty has been experienced in trying to sort out the various species, even with the aid of the internal male genitalia. We must have a thorough host plant study to be able to satisfactorily accomplish this task. The females, except in a very few instances are practically useless when it comes to characters of specific value. Color pattern of the dorsum, especially of the vertex, has been used wherever possible. The length and breadth of the vertex were also useful in separating some of the more complex groups. The characters of most value, however, are to be found in the internal male genitalia, especially in the lateral view of the aedeagus with its processes.

This study is based on the material in the Snow Entomological Collection, that in the United States National Museum, and that in the collection of Doctor E. D. Ball

*Contribution from the Department of Entomology, University of Kansas.

of Tucson, Arizona.

The genus Osbornellus was separated from Scaphoideus and nicely characterized by Doctor E. D. Ball with **Scaphoideus auronitens** (Prov.) designated Genotype. (New Genera and Species of Leafhoppers Related to Scaphoideus, Journal Washington Academy of Science, Vol. 22, January 4, 1932, E. D. Ball). It is easily recognized by the long attenuate tips to the plates of the males. Eleven old species have been recognized (including one from Mexico which may occur in the U. S.) and thirteen are here described for the first time.

Key to the Species of Osbornellus

1. Margin of vertex definite, at least near apex, usually marked with two more or less parallel lines excepting (**O. albonototus**) 2
   Margin of vertex rounded, markings not connected nor parallel 7
2. Vertex with orange markings 3
   Vertex without orange markings 6
3. Orange markings of vertex transverse 4
   Orange markings of vertex longitudinal 5
4. Female with median notch in last ventral segment; male plate to attenuation one third longer than greatest width .... **auronitens** (Prov.) Fig. 1
   Female without median notch in last ventral segment; male plates to attenuations barely longer than greatest width .... **rotundus** n. sp. Fig. 3
5. Larger species 5.5 to 6.5 mm. in length .... **jucundus** (Uhler) Fig. 2
   Smaller species, 4 to 4.75 mm. in length .... **cocanus** Ball Fig. 5
6. Lines of vertex margin often not continuous nor parallel. Elytra with white areoles .... **albonotatus** (V. D.) Fig. 6
   Lines of vertex continuous and almost parallel. Elytra without white areoles. ...... **ritanus** Ball Fig. 4
7. Vertex concolorous .... **unicolor** (Osb.) Fig. 7
   At least some color pattern on vertex 8
8. Dorsum appearing slightly cross-banded 9
   Dorsum not cross-banded 11
9. Head, pronotum, and scutellum much darker than elytra yellowish brown, very few lighter aereoles in elytra .... **ignavus** Ball Fig. 8
   Dorsum with lighter band just back of scutellum;

many light aereoles in elytra; veins dark, color fuscous 10

10. Fasciate appearance more definite; vertex sharper, with more light markings at base; processes of aedeagus well-developed, as long as shaft .... **bifasciatus** n. sp. Fig. 9
Not so plainly cross-banded; vertex less sharp with more of base covered with fuscous; processes of aedeagus attenuate, not reaching to tip of shaft .... **tenuis** n. sp. Fig. 10

11. Markings of vertex sharply defined 12
Margins of markings of vertex rather indefinite, suffused 14

12. Two basal white spots of vertex typical L-shaped ..13
Basal white spots consisting of four longitudinal dashes .... **decorus** n. sp. Fig. 11

13. Pygofer of male truncate; yellow area of disc of vertex large; dark lines of apical portion sharp .... **clarus** n. sp. Fig. 12
Pygofer of male rounded; black transverse bar of disc of vertex very large..(Ariz.).. **omani** n. sp Fig. 13

14. Length of vertex longer than width between eyes ..15
Length of vertex about the same or shorter than width between eyes 18

15. Large, 6 mm. or more .... (Calif.) .... **curvatus** n. sp. Fig. 14
Smaller, usually about 5 mm. 16

16. Apices of male plates much more slender; shaft of aedeagus straight with processes resembling deer antlers....(Kans.-Mo.) .... **corniger** n. sp. Fig 15
Apices of male plates broad; aedeagus curved, processes not forked. 17

17. Markings of dorsum rather indefinite; aedeagus in lateral view not unusually wide, processes longer than shaft.....(Calif.) ..... **scalaris** (V. D.) Fig. 16
Markings of dorsum more clearly defined; aedeagus in lateral view about one-fourth as wide on basal half as length, processes very slender, not as long as shaft....(Ariz.) .... **spicatus** n. sp. Fig. 17

18. Vertex wider between eyes than median length ..19
Vertex of about same width as length 21

19. Very dark colored, almost black ...... (Ariz., N. Mex.) .... **fumidus** n. sp. Fig 18
Of usual tawny color 20

20. Smaller species 5 mm; processes of aedeagus about one-fifth length of shaft....(Mex.) .... **mexicanus** (Osb.) Fig. 19
Larger species, 6 mm. and over; aedeagus with large processes......(Conn. to Miss.) .... **alatus** n. sp. Fig. 20
21. Male pygofer with truncate apices 22
Male pygofer with rounded apices 23
22. Usually quite lightly marked; aedeagus of about same width throughout with processes almost as wide....(Ariz.) .... **pallidus** n. sp. Fig. 21
Usually much darker, markings elongated giving a lineate appearance; aedeagus in lateral view more than twice as wide at base as apex, processes very slender....(Ariz.) .... **lineatus** n. sp. Fig. 22
23. Processes of aedeagus with many branches....(east of Mississippi River) .... **consors** (Uhler) Fig. 23
Processes of aedeagus not branched 24
24. Shaft of aedeagus in lateral view broad, straight, processes greatly widened on middle half....(Tex.) .... **ater** n. sp. Fig. 25
Shaft of aedeagus in lateral view of about same width throughout, narrow, curved, processes not thickened over so much of their length if at all .... (N. W. U. S. & Can.). .... **borealis** DeL. Fig. 24

Osbornellus auronitens (Prov.)

Scophoideus auronitens Provancher, Pet. Faune Ent. Can., iii, p. 277, 1889.

"2 Golden-flash Scophoid. **Scophoideus auronitens,** n. sp.

Length, 5.6 mm. Clear, horn-yellow; the vertex reddish with a pale line at the base and a small triangle at the tip circumscribed by dark lines, three dark lines run also on the border of one eye to the other. The prothorax and the scutellum each with a reddish band at the base. Elytra of a beautiful clear, brilliant horn-yellow with nervures a little darker, forming at the outer edge toward the apex two large, elongated cells; the clavus bears on its inner margin three spots or small brown lines. Wings white with brown nervures. Venter pale yellow. Posterior legs with black tips.—Red cap.

Quite distinct from the preceding by its coloration and the cells of its elytra. Mr. Uhler had, it appeared,

given to this insect the name of **jucundus**, but having described nowhere that we know of, we have believed it necessary to give it the present name."

This species is outstanding with its bright orange band on the vertex and the female with the last ventral segment with a median notch.

Genitalia. Last ventral segment of female more than twice as broad as preceding, lateral margins broadly rounding, posterior margin with V-shaped notch usually deep, often extending two-thirds distance to base. Male valve broadly rounding; plates about as wide at base as valve, at least one third longer to filamentous portion than greatest basal width; styles with outer half heavy with sides almost parallel, apex rounded slightly concave on outer margin just before apex. Aedeagus in lateral view of medium size slightly curved dorsally, with pair of broad processes arising laterally just before base of shaft, flaring slightly, extending just beyond apex of shaft in dorsally pointed apices.

Specimens have been examined from the following localities: Notchland, N. H.; New Haven, Conn.; Vineland, Ont.; Ithaca, N. Y.; Windsor, Vt.; Douglas Co., Kans.; Ottawa Co., Okla.; Walnut, N. C.; Ashton, Md.; Itasca St. Park, Minn.; Plummers Id., Md.; East River, Conn.; Washington, D. C.; Fairfax Co., Va.; Long Id., N. Y.

Osbornellus rotundus n. sp.

Resembling **O. auronitens** (Prov.) but vertex more acute, posterior margin of last ventral segment of female convexly rounded, male plates to the beginning of filament almost quadrate, processes of aedeagus slender and longer than shaft, outer half of styles with sides not parallel and often with small knobs at apex. Length, 5 mm. to 5.5 mm.

General color tawny. Vertex margin light with three dark lines running almost parallel from eye to eye, the lower dark band lighter. Disc of vertex with broad band of orange connecting each eye with dark median dash on its anterior border. Pronotum with anterior margin between eyes orange, back of which is a more or less definite row of darker spots. Elytra tawny with lighter areoles. Clavus with three dark spots on mesal margin and usually another on claval suture.

Genitalia. Last ventral segment of female with posterior margin almost truncate to slightly extended medially. Male valve broad, usually with an angular extension between plates; plates to the beginning of the attenuation almost as wide as long, distinctly shorter than in **O. auronitens**; styles with outer half narrowed, tapering to slightly knobbed tips; aedeagus rather long and slender, slightly curved dorsally with a pair of lateral processes arising one-fourth distance from base, slightly diverging from shaft, gradually tapering to sharp apices; pygofer rather narrow with rounded apex.

Holotype male, allotype female, Tuskegee, Ala., July 22, 1930, L. D. Tuthill. Paratypes as follows: nine males, ten females, Tuskegee, Ala., July 22, 1930; 11 males, eight females, Lexington, S. C., August 24, 1930; one male, three females, Plattsburg, Ga., July 25, 1930; seven males, four females, Okefenokee Swamp, Ga., August 3, 1934; three males, nine females, Dismal Swamp, Va., August 13, 1934; eight males, thirteen females, Iuka, Miss., July 14, 1930; fifteen males, eight females, Ft. Meade, Fla., Aug. 13, 1930; four males, nine females, Lake Drummond, Va., Sept. 10, 1933, P. W. Oman; one male, five females, Washington, D. C., July 28, 1931; thirteen males, eight females, East River, Conn., 1910; types and paratypes in Snow Entomological Collection and in the U. S. N. M.

Osbornellus jucundus (Uhler)

Scaphoideus jucundus Uhler, Md. Acad. Sci., i, p. 34, 1889.

This beautiful reddish brown species is easily separated from **O. auronitens** and **rotundus** by the two longitudinal orange spots on the vertex instead of the transverse one in the latter and by the very elongate plates of the male.

Genitalia. Posterior margin of last ventral segment of female almost truncate, very slightly produced with an indication of a median notch. Valve of male triangular; plates very long and slender, length to attenuation more than twice that of widest place; styles long and slender, rather straight for the genus; aedeagus in lateral view curved ventrally, shaft long with a pair of retrorse diverging, curving, apical processes, about one-third as long as shaft; pygofer short, broad at base and narrowing rapidly to rounded tips.

A female in the U. S. N. M. bearing the following

label in Uhler's handwriting **"Scaphoideus jucundus** Uhler, Md." is here designated Lectoholotype and a male, Berlin, Md., June 26, 1933, described above, neoallotype.

Osbornellus cocanus Ball

Osbornellus cocanus Ball, E. D., Jr. Wash. Acad. Sci., Jan. 4, 1932, p. 18.

This beautiful little species is well characterized by Doctor Ball. It is like **O. jucundus** but much smaller, with longer and more acute vertex.

Genitalia. Male valve angular but not so acute as in **O. jucundus;** plates narrow, more than twice as long to attenuation as greatest width, attenuation slender, not so long as basal portion; styles abruptly narrowed slightly beyond middle, slender portion gradually narrowing to apices; aedeagus in ventral view curved slightly ventrally with pair of retrorse, almost straight apical processes; pygofer almost as broad as long, apical portion abruptly narrowed on outer margin, apex sharp.

Types examined. In collection of Dr. Ball. One paratype in Snow Entomological Collection.

Osbornellus albonotatus (Van Duzee)

Scaphoideus albonotatus Van Duzee, E. P., Bull. Buf. Soc. Nat. Sci., ix, p. 226, 1909.

This species is well characterized by the general dark coloring together with the three pairs of white spots of the clavus and the aedeagus narrowed in the middle with its pair of apical, retrorse, curving processes.

Genitalia. Last ventral segment long with lateral margins almost straight, posterior margin almost truncate. Male valve semi-circular; plates narrower at base than valve, basal portion considerably longer than attenuated flaccid apices; styles broad on basal two-thirds, apical third suddenly narrowed to one-fourth basal width with parallel sides; aedeagus in dorsoventral view with broad base, shaft narrowed at middle to about one-third basal width, with pair of dorsal, retrorse, outwardly curving processes, about one-fourth distance from tip.

Specimens are at hand from Likely, Fla., Cocoanut Grove, Fla., Okefenokee Swamp, Ga., and Virginia Beach, Va. Numerous other specimens were examined from Sanford, Fla.

Osbornellus ritanus Ball

Osbornellus ritanus Ball, E. D., Jr. Wash. Acad. Sci.,

p. 17, 1932.

That Doctor Ball correctly placed this species as near **O. auronitens** is substantiated by the form of the internal genitalia of the male.

Genitalia. Male valve quite short, sides almost parallel; plates narrow at base, small, length to attenuation about twice that of greatest width, attenuated portion at least twice as long as basal, quite broad; styles abruptly narrowed on outer third, apical third with sides almost parallel, slight bump on middle of inner margin, apex notched; aedeagus short, stout, slightly curved dorsally, tapering toward apex, pair of processes arising ventrally, wider than shaft and about one-half longer, tapering to sharp apices.

Numerous specimens at hand from high in the mountains of southern Arizona.

Osbornellus unicolor (Osb.)

Scaphoideus consors var. **unicolor** Osborn, Herbert J., Cinc. Soc. Nat. Hist., xix, p. 196, 1900.

Easily distinguished from all the other species by the dense brown coloring without definite markings on anterior half of body.

Genitalia. Last ventral segment of female at least twice as long as preceding, lateral margins broadly rounded, posterior margin almost truncate, often slightly excavated either side a short median tooth. Male valve almost parallel sided; plates narrower at base than valve, length to attenuation mòre than twice greatest width; styles narrowed on outer half, enlarging at apex to truncate tips; aedeagus composed of two bifid structures, the ventral one about half as long as dorsal, much broader, apparently constructed so as to receive the dorsal member in its forked apex.

Specimens are at hand from Mississippi, Louisiana, Georgia, Florida and North Carolina.

Osbornellus ignavus Ball

Osbornellus ignavus, Ball, E. D., Bull. Brook. Ent. Soc., XXXI, 1, p. 18, 1936.

This beautiful western species is easily separated by the much darker coloring of the pronotum and scutellum.

Genitalia. Last ventral segment of female long, lateral margins rounded to an evenly convex posterior margin; male valve short and broad; plates narrower at base than valve, length to attenuation one-third more

than greatest width; styles on outer third narrowing to long slender tips; aedeagus in lateral view long and slender, curved dorsally with pair of long slender processes arising near base of shaft, running almost parallel to and slightly beyond tip of shaft.

Paratypes from the type locality are at hand.

Osbornellus bifasciatus n. sp.

Resembling **O. tenuis** but more distinctly two banded and male aedeagus in lateral view almost straight with processes of about same width and length. Length 5.5 mm.

Vertex acute, less than a right angle, width between eyes distinctly less than length at middle.

Color. General ground color cinereous, vertex, pronotum, and scutellum and posterior half of elytra darker. Face fuscous with numerous incomplete light arcs. Vertex marked as usual in this group with dark markings heavy, lighter areas weak. The outstanding feature of the coloring is the unusually large light area in the region of the base of clavus and corium giving the species a two banded appearance.

Genitalia. Last ventral segment of female about twice as long as preceding, posterior margin angularly produced, a semblance of a median notch at middle. Male valve very short, roundingly obtuse with slight projection at middle; plates narrower at base than valve, length to attenuation at least twice that of greatest width, attenuated portion narrow and much shorter than basal; styles abruptly narrowed near middle, outer half almost straight on outer margin, inner margin narrowing for half its distance, then parallel with outer margin; aedeagus in lateral view almost straight from near base to tip with pair of ventral processes of about same width and length.

Holotype male, Santa Rita Mts., Ariz., July 5, 1933, E. D. Ball; allotype female and one paratype female, same data except taken June 30, 1930. In collection of E. D. Ball.

Osbornellus tenuis n. sp.

Resembling **O. clarus,** but with less white markings on vertex, generally a little darker, with pygofer broad and short with apex rounded and aedeagus in lateral view nearly straight with processes attenuated, not much more than two thirds length of shaft. Length 5-5.5

mm.

Vertex about a right angle, length between eyes slightly less than median length, margins slightly arcuate.

Color. General color cinereous tinged with tawny marked with fuscous. Vertex typical of the group with markings fairly distinct. Elytra with large whitish areoles, veins dark.

Genitalia. Last ventral segment of female more than twice as long as preceding, lateral margins broadly rounded to middle of posterior margin. Male valve broad, obtusely angular; plates narrower at base than valve; length to attenuation less than twice that of greatest width, attenuated tips about as long as basal portion; styles abruptly narrowed near middle, outer third quite slender, tip slightly enlarged; aedeagus in lateral view straight on basal two-thirds, then slightly bent dorsally, basal ventral processes very weak and attenuated, reaching to about the outer fourth of shaft.

Holotype male, allotype female, one male and three female paratypes, Atascasa Mt., Ariz., E. D. Ball. Other paratypes as follows: one male and one female, Oak Creek Canyon, Ariz., R. H. Beamer; one male, Long Valley, Ariz., E. D. Ball; one male, Tucson, Ariz., E. D. Ball; one male, Huachuca Mts., Ariz., June 11, 1933, P. W. Oman. Types and paratypes in Ball's collection, paratypes in Snow Entomological collection and U. S. N. M.

Osbornellus decorus n. sp.

Resembling **O. omani** n. sp., but with even more dark markings on the vertex, the middle cross band of which encloses a small white spot on each side, the vertex more sharply angled and the aedeagus in lateral view much longer, bent dorsally, then ventrally, on outer third. Length 5 mm.

Head acute, less than a right angle; median length of vertex almost one-third more than width between eyes.

Color cinereous marked with fuscous. Vertex dark with the following light marks: apical spot with very small lateral wings, triangular spot just back of this, two light dashes almost connecting this to ocelli, three pairs of more or less longitudinal basal dashes, outer touching eye, the next, small, almost connected to outer with a light dot in black field forward of anterior end, and long

inner pair. Veins of elytra dark, more or less bordered with fuscous.

Genitalia. Male valve short, obtusely rounded; plates broad, length to attenuation about one-third longer than greatest width, attenuate tips narrow, about equal in length to basal portion; styles abruptly narrowed near middle, bent sharply out, tapering to slender apices; aedeagus in lateral view long, bent dorsally, outer third tapering slightly, curved back ventrally, pair of weak processes arising near first bend, extending to tip; pygofer much longer than wide, free portion very short, apex truncate.

Holotype male, Dulzura, Calif., Aug. 9, 1935, R. H. Beamer. In Snow Entomological Collection.

Osbornellus clarus n. sp.

Resembling **Osbornellus consors** (V. D.) but usually easily separated by the brilliance of the dark fuscous lines and yellow spots of the vertex, by the very slender, dorsally curved aedeagus with the accompanying long slender processes and by the truncate apices of male pygofers. Length 5 to 5.5 mm.

Vertex about a right angle, margins rounded, length about equal to width between eyes.

Vertex characterized by clear cut markings. Markings as in **O. scalaris** (V. D.) but more definite. Apex with white dot with lateral wing-like projections on margins of vertex and median white triangle more or less connected to dot, all bordered by quite definite fuscous lines; scutellum quite light, basal angles with large dark spots. Elytra cinereous, veins darker.

Genitalia. Last ventral segment of female twice as long as preceding; posterior margin evenly produced from rounded lateral angles. Valve of male short, slightly angled; plates narrower than valve at base, length to attenuated portion scarcely twice that of greastest width; styles sharply narrowed near middle, slightly angled out, gradually tapered to tips with slight bump on inner margin near middle of tapered portion; aedeagus in lateral view long and very slender, curved dorsally with a pair of very slender curved processes arising ventrally at base and extending about to apices of shaft; pygofer wider at base of anal tube than length from there to tip, apex truncate.

Holotype male, allotype female, Doniphan Co., Kans.,

July 20, 1924. Paratypes as follows: 7 females, 8 males, Douglas Co., Kans., Trap Light, Paul B. Lawson, 1928-1930; 2 males, Tigerville, S. C., 1930; 1 male, 4 females, Houma, La,. 1931; 2 females, Leland, Miss., 1921; 1 male, Hamilton, Miss., 1930; 1 female, Prairie. Miss., 1921; 1 female, Prattsburg, Ga., 1930; 1 female, Fulton, Miss., 1930; 1 male, Orange Co., Texas, 1928: 1 female, Tallulah, La., 1929; 1 female, Shuqualak, Miss., 1930; 1 female, Tuskegee, Ala., 1930; 1 female, Hilliard, Fla., 1930; 4 males and 2 females, Sanford, Fla., 1933-34; two females, Meridian, Miss., 1930; 1 female, Barnes, Ariz., 1932; in U. S. N. M. 1 male, Ocala, Fla., 1923; 3 males, College Park, Md., 1933; 2 males, Berlin, Md., 1933; 2 females, 1 male, Annapolis, Md., 1932; 1 male, Bristol, Ky., 1933; 2 males, Savannah, Ga., 1933; 1 female, Washington, D. C., 1932; 2 males, 1 female, Kerrville, Tex., 1906; 2 females, Victoria, Tex., 1915; 1 pair, Vienna, Va., 1932; 7 females and 6 males, Sanford, Fla., E. D. Ball.

Osbornellus omani n. sp.

Resembling **O. clarus** but with all markings generally much darker, especially the fuscous rectanglar spot just back of the light triangle on anterior portion of vertex, which occupies most of the upright of the light L-shaped marks usually present at base of vertex and the aedeagus of the male with its processes which contact shaft and extend to outer third. Length 5 mm.

Vertex blunt, slightly more than a right angle; as wide between eyes as length at middle; ocelli of male very large, touching eye.

Color. General ground color brownish gray, profusely marked with fuscous. Vertex with usual apical light spot connected to ocelli with arcuate light bands bordered with fuscous; median light triangle with yellow spots each side, and more or less rectangular fuscous spot just caudad; normal light L-shaped basal spots reduced to rectangular ones with concave anterior borders. Pronotum irrorate with fuscous. Scutellum dark, with a few light inclusions. Elytra dark with usual lighter areoles, veins quite dark.

Genitalia. Last ventral segment of female at least twice as long as preceding, lateral margins rounded from the base to middle of posterior margin. Male valve short, margins almost parallel; plates narrower at base

than valve, length to attenuation slightly more than greatest width; styles strongly narrowed and bent slightly outward near middle, outer half straight and slightly tapered to tip; aedeagus in lateral view fairly broad at base, narrowed on outer third with a pair of closely appressed processes arising ventrally at base and ending in sharp points at outer third.

Holotype male, allotype female, five female paratypes, Patagonia, Ariz., R. H. Beamer; additional paratypes; 2 males and 9 females, Patagonia, Ariz., June 24, 1933, P. W. Oman; 7 males and 10 females, Patagonia, Ariz., E. D. Ball.

At least a portion of the type series was taken from sycamore. Types in Snow Entomological Collection, paratypes in U. S. N. M. and collection of E. D. Ball.

Osbornellus curvatus n. sp.

Resembling **O. scalaris** (V. D.) but definitely larger, 6 mm. or more in length, pygofer barely longer than wide and male style with outer fourth much thinner. Length 6-6.25 mm.

Vertex rather sharp, about a right angle, median length slightly greater than width between eyes.

Color General ground color cinereous marked with fuscous. Vertex with typical marking for this group with lateral wing-like marks to median triangle rather definite, also the dark border to the L-shaped light marks of base pronounced. Elytra with light areas somewhat larger than usual, veins darkened.

Genitalia. Last ventral segment of female at least twice as long as preceding, lateral angles broadly rounded to middle of posterior margin. Valve of male short, obtusely angular; plates broad at base, but narrower than valve, length to attenuation about twice as long as greatest width, attenuated portion considerably shorter than basal, narrow for the size of the insect; styles abruptly narrowed near middle, inner margin of outer half converging to long narrow tips, outer margin almost straight; aedeagus in lateral view of medium size, slightly curved dorsally and narrowing toward tip with pair of ventral processes arising at base of shaft, narrow at base, widening to outer third then narrowing to sharp apices slightly beyond apex of shaft. Pygofer very short and broad, scarcely longer than wide, lower posterior margin converging or narrowing to dorsal.

Holotype male, allotype female, Giant Forest, Calif . July 28, 1929, R. H. Beamer; paratype male, Yosemite, Calif., June 29, 1931, E. D. Ball. Types in Snow Entomological Collection, paratypes in collection of E. D. Ball.

Osbornellus corniger n. sp.

Resembling **O. scalaris** n. sp. but with attenuated apices of male plates more slender and with long, straight slender aedeagus in lateral view with paired processes that resemble deer antlers. Length 5-5.25 mm.

Vertex acutely angled, especially the male, median length almost one-fourth longer than width between eyes. Ocelli large, close to eyes.

Color. General ground color tawny as in **O. clarus**, except that only anterior dark lines of vertex are sharp; the yellow spots are broader and posterior markings of vertex tend to fade out. Elytra tawny sub-hyaline, with usual lighter areoles, veins darker in spots.

Genitalia. Last ventral segment of female almost three times as long as preceding; lateral angles broadly rounded to truncate posterior margin. Male valve long for this genus, with small projection between plates; plates narrower at base than valve, length to attenuation about one third longer than greatest width; styles gradually narrowed from base to tip, bent out near middle; aedeagus in lateral view long, slender, straight, with pair of ventral, antlered processes arising at base, extending directly away from shaft, then bent parallel with it, ending in long slender tips beyond end of shaft; pygofer broad at base, short with rounded apices.

Holotype male, allotype female, and two male paratypes, Douglas County, Kan., Light Trap, Paul B. Lawson; other paratypes, one male, Douglas Co., Kan., E. S. Tucker; and one male, Atherton, Mo., C. F. Adams. Types in Snow Entomological Collection.

Osbornellus scalaris (Van Duzee)

Scaphoideus scalaris Van Duzee, E. P., Ent. Am., vi, p. 51, 1890.

This species resembles **O. consors** (Uhler) but vertex is sharper, and distinctly longer than width between eyes, while **consors** is about the same, aedagus long and slender with processes unbranched.

Genitalia. Last ventral segment of female very long, lateral margins broadly rounded to rather truncate posterior margin which appears almost notched in mak-

ing the angle over the ovipositor. Male valve very broad, sides almost parallel; plates narrower than valve at base, length to attenuation about one third longer than greatest width; styles abruptly narrowed at middle, tapering to slightly enlarged apices with a small tooth on inner margin near outer fourth; aedeagus in lateral view narrow, slightly curved dorsally with pair of processes arising ventrally near base of shaft, swerving with shaft to flare away from it near its apex, about one-fourth longer than shaft; pygofer rather short, mᵔasured at base of anal tube slightly broader than from the same place to apex.

Lectoholotype male, California Coq., Lectoallotype female, California Coq., No. 623, two cotypes in the Iowa State College collection, Ames, Iowa, described above are here designated. Specimens are at hand from: Orange Co., Calif.; San Diego Co., Calif.; Monrovia, Calif.; Nipomo, Calif.; Alpine, Calif.; Santa Cruz Co., Calif.

Osbornellus spicatus n. sp.

Resembling **O. scalaris** (V. D.) but markings of dorsum more definite, and aedeagus in lateral view very broad, longer than processes and many times as wide at the base. Length 5 mm.

Vertex acute, distinctly longer than width between eyes.

Color tawny with lighter areoles and darker spots. Vertex light with an unusual amount of golden yellow. Elytra suffused tawny with lighter areoles and darker spots; veins darker in some portions.

Genitalia. Last ventral segment of female more than twice as long as preceding, lateral margins broadly rounding to middle of posterior margin. Valve of male short, broadly rounded; plates broad at base, length to attenuation about one-third more than greatest width, attenuations narrow and shorter than basal portion; styles abruptly narrowed slightly before middle, sides converging to somewhat enlarged tips; aedeagus in lateral view almost one-fourth as wide at base as total length, almost straight, sides almost parallel to middle, then converging to sharp somewhat hooked tip, ventral basal processes very slender, not reaching apex; pygofer almost twice as long as greatest width, apex almost truncate.

Holotype male, allotype female, Granite Dell, Ariz., July 30, 1933, R. H. Beamer; 1 male paratype, Granite

Dell, Ariz., August 17, 1929, E. D. Ball. Types in Snow Entomological Collection, paratype in collection of E. D. Ball.

Osbornellus fumidus n. sp.

Resembles **O. mexicanus** (Osb.) but much darker in color, almost entirely smoky, head much blunter with markings suffused and aedeagus of male in lateral view at least twice as wide as processes and separated from them by its own width. Length 5 to 5.5 mm.

Vertex rather blunt, almost one-fourth wider between the eyes than median length. Ocelli very large, light colored.

Color dark, almost fuscous throughout. Vertex dark except apical spot with lateral wings, small triangle near middle and two small spots in basal angles. Remainder of dorsum usually heavily infuscated. Veins of elytra darker with a few lighter areoles in clavus and corium.

Genitalia. Last ventral segment of female almost three times as long as preceding, lateral margins rounded to almost flat posterior margin. Male valve short, obtusely angular; plates narrow at base, about twice as long to attenuation as greatest width, attenuations scarcely as long as basal portion of medium width; styles abruptly narrowed at middle, tapering on outer half to rather slender, almost knobbed tips; aedeagus in lateral view of about equal width throughout, curved dorsally with ventral processes arising at extreme base, about one-third as wide as shaft, separated from it by about its own width, extending parallel with it to tip; pygofer about twice as long as wide with rather rounded apex.

Holotype male, allotype female taken as a mating pair, and three male paratypes, Monument, Colo., August 19, 1936, R. H. Beamer; paratypes as follows: two males and seven females, Chiricahua Mts., Ariz., E. D. Ball; one male, Silver City, New Mexico, July 22, 1936, D. R. Lindsay; one male, Huachuca Mts. Ariz., July 20, 1933, E. D. Ball; one male, Long Valley, Ariz., E. D. Ball. Types and paratypes in Snow Entomological Collection; paratypes in collection of E. D. Ball.

Osbornellus mexicanus (Osb.)

Scaphoideus mexicanus Osborn, Herbert Jr., Cinn. Soc. Nat. Hist., June 26, 1900, p. 197.

Resembling **O. scalaris** (Van D.) but vertex much blunter, width between eyes distinctly greater than

median width and male aedeagus in lateral view long, slender, strongly curved dorsally with processes at base of shaft scarcely one-sixth as long as shaft.

Genitalia. Last ventral segment of female more than twice as long as preceding, lateral margins rounded almost from base to middle of posterior margin. Male valve short, angular; plates narrower than valve, length to attenuation less than twice greatest width; flaccid tips rather broad, longer than basal portion; aedeagus in lateral view narrow, long and strongly curved dorsally with ventral basal processes reduced to about one-sixth length of shaft; pygofer broad at base, rapidly narrowing to semi-truncate apex.

Female specimen No. 5402 in U. S. N. M., Orizaba, V. C., Mex., Sept. 16, 1892, is here designated lectoholotype.

Osbornellus alatus n. sp.

Resembling **O. mexicanus** (Osb.) but distinctly larger, deeper brown in color and male aedeagus in lateral view straight, with processes much broader and longer than aedeagus. Length 6-6.5 mm.

Vertex. Rather blunt, a little wider than long.

General ground color tawny. Darker and lighter marks of vertex merging, barely a semblance of the usual light and dark areas. Elytra tawny with the usual lighter areoles.

Genitalia. Last ventral segment at least twice as broad as preceding, lateral margins broadly rounding to truncate posterior margin. Valve of male broadly angular with small median projection between plates; plates at base narrower than valve, length to attenuations less than twice greatest width, flaccid apices long and slender; styles rapidly narrowed near middle, outer half tapering and bending slightly out; aedeagus in lateral view long, narrow and almost straight with pair of ventral processes arising at base of shaft, curving ventrad, then parallel to shaft, outer margins serrate but not branched, tips long and slender; pygofer short and heavy, apex broadly rounded.

Holotype male, allotype female and one female paratype, New Haven, Conn., August 20, 1934, R. H. Beamer; 2 male paratypes, Iuka, Miss., July 14, 1930, R. H. Beamer; and four female paratypes in U. S. N. M., from the following localities: 2, Vienna, Va., 1932; 1, Lehigh Gap, Pa., 1909; and 1, Relay St., Md. Types in

Snow Entomological Collection.

Osbornellus pallidus n. sp.

Resembling **O. clarus** n. sp. but usually distinctly pale in color, without the definite markings of the vertex, with the pygofer narrower at apex when compared to median width and processes of aedeagus as long as, or longer than, shaft. Length 5 to 5.5 mm.

Vertex about a right angle, length at middle about equal to width between eyes.

Color. General color tawny, lightly marked with fuscous. Vertex marked about as in most of other species, but rather indefinite except the anterior dark line which is usually heavy. Veins of elytra darker, the usual dark spots very light and indefinite.

Genitalia. Last ventral segment of female more than twice as long as preceding, lateral margins broadly rounding to middle of posterior margin. Male valve very broad and narrow, sides almost parallel; plates narrower than valve at base, length to attenuation not quite twice that of greatest width, attenuated portion not quite as long as basal, narrow; styles abruptly narrowed near middle, outer half quite slender, small hump on inner margin; aedeagus in lateral view very long and slender, curved dorsally with a pair of ventral processes arising at base and extending in a curve with shaft, clearing it, ending at or beyond apex of shaft; pygofer about one-fifth longer than greatest width, apex truncate, noticeably narrower in relation to its greatest width than in the case of **O. clarus.**

Holotype male, allotype female, four female and eight male paratypes, Patagonia, Ariz., June 24, 1933, R. H. Beamer; twenty-four paratypes, Patagonia, Ariz., 1933, P. W. Oman. Types and paratypes in Snow Entomological Collection, paratypes in U. S. N. M., and in collection of Doctor E. D. Ball.

Osbornellus lineatus n. sp.

Resembling **O. pallidus,** but darker, markings more in longitudinal lines and the aedeagus in lateral view three times as thick at base as at apex. Length 5-5.5 mm.

Vertex rather pointed in the male, somewhat blunter in the female, about as wide as long.

Color tawny with darker lineate markings. Vertex with marks of usual type, more definite than in **O. pallidus.** Veins of Elytra darker spots elongated so that general appearance is lined.

Genitalia. Last ventral segment of female at least twice as long as preceding, lateral angles broadly rounding to middle of posterior margin. Valve of male short, triangular; plates rather broad, length to attenuation not quite twice greatest width, attenuation rather heavy, longer than basal portion; styles abruptly narrowed near middle, apical portion with sides converging to outwardly rounded tips, small bump on inner margin near middle; aedeagus in lateral view at least three times as broad at base as at tip, curved dorsally ventral processes arising before base, very narrow, not more than one-third as wide as shaft at apex, extending to tip of shaft; pygofer much longer than wide, outer half with sides almost parallel, with corners rounded to flat tip.

Holotype male, allotype female, Patagonia, Arizona, June 24, 1933, R. H. Beamer; paratypes as follows: one male, Oak Creek Canyon, Ariz., August 14, 1927, R. H. Beamer; two males and three females, Patagonia, Ariz., E. D. Ball; one female, same place, R. H. Beamer; one female, Granite Dell, Ariz., E. D. Ball. Types and paratypes in Snow Entomological Collection, paratypes in collection of E. D. Ball.

Osbornellus consors (Uhler)

Scaphoideus consors Uhler, Md. Acad. Sci., i, p. 36, 1889.

Genitalia. Last ventral segment of female very long, lateral margins rounded to flattened median third which in turn has a small v-shaped notch. Valve of male short and broad, front and hind margins almost parallel, small tooth between plates; plates to attenuation about one third longer than greatest width, very few hairs on filaments; styles bent out and gradually narrowed on outer half; aedeagus in lateral view about five times as long as wide, with pair of many branched ventral processes arising near base, extending slightly beyond tip of shaft.

A female specimen in U. S. N. M., labeled as follows in Uhler's handwriting, "**Scaphoideus consors** Uhler Spice B. Halls sp." is here designated lectoholotype and the male, Vienna, Va., J. C. Bridwell, Sept. 1, 1932, agreeing with the female and described above, neoallotype. Other specimens are at hand from the following localities: College Park, Md., Mosquito trap, F. C. Bishop; Glen, N. H., Aug. 20, 1934, P. W. Oman; Notchland, N. H., August 20, 1934; Willow River, Minn., August 7, 1922, H. H. Knight; Iuka, Miss., July 14, 1930; Tiger-

ville, S. C., August 26, 1930; Prattsburg, Ga., July 25, 1930; New Haven, Conn., August 20, 1934; Polk County, Ark., August 21, 1928.

Osbornellus ater n. sp.

Resembling **O. clarus** n. sp. but without the definite markings of the vertex, with the aedeagus straight and broad in lateral view, and with the processes greatly broadened in middle. Length 4.75 mm.

Vertex rather acute, less than a right angle. Median length about the same as width between the eyes.

Color tawny with few darker markings. Vertex with usual pattern but the whole suffused so as to appear indefinite. Elytra with veins about the same color as remainder, a few lighter areoles and darker portions near apex.

Genitalia. Valve of male short, anterior margin broadly rounded with small median projection; plates rather broad, length to attenuation less than twice that of greatest width, attenuated portion short and narrow, considerably less than basal length; styles abruptly narrowed near middle, bent out and narrowed to slender apices; aedeagus in lateral view broad and straight, slightly enlarged on dorsal margin near apex, ventral processes arising basally, greatly enlarged on middle two-thirds, extending about one-third their length beyond aedeagus; pygofer about twice as long as wide, normal in shape with rounded apex.

Holotype male, Cameron Co., Tex., August 3, 1928, R. H. Beamer; one paratype male, Rock Springs, Tex., July 9, 1936, R. H. Beamer. In Snow Entomological Collection.

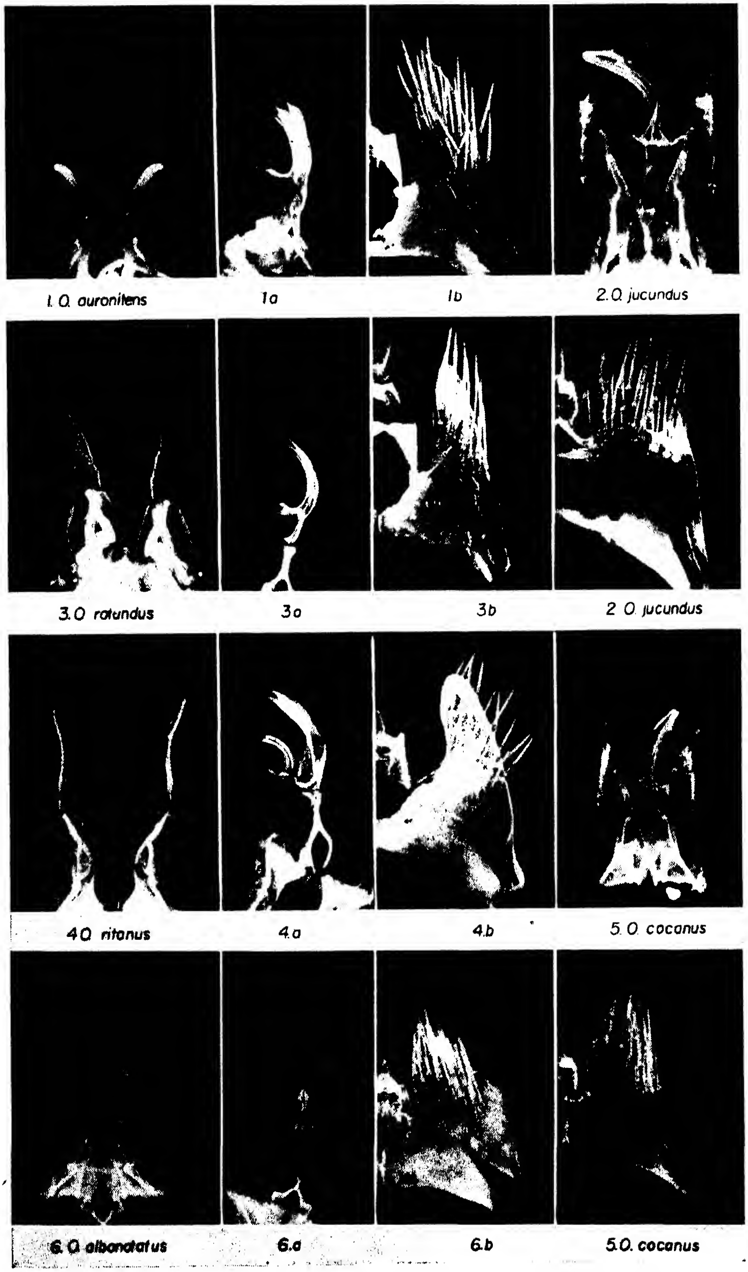
Osbornellus borealis DeL. & Mohr

Osbornellus borealis DeLong, D. M. & Mohr, C. O., Am. Mid. Nat., vol. 17, No. 6, p. 976, 1936.

Resembling **O. scalaris** (V. D.) but width of vertex about the same as length instead of distinctly longer, male pygofer apically more acute and aedeagus in lateral view slightly broader with processes only slightly longer than shaft of aedeagus, while **scalaris** usually has the processes about one third longer than shaft.

There are numerous specimens at hand from the Northwestern United States and many localities in British Columbia. If I have determined this species correctly, it is the common species in the Northwest, while **O. scalaris** is the common one in southern California.

PLATE I.



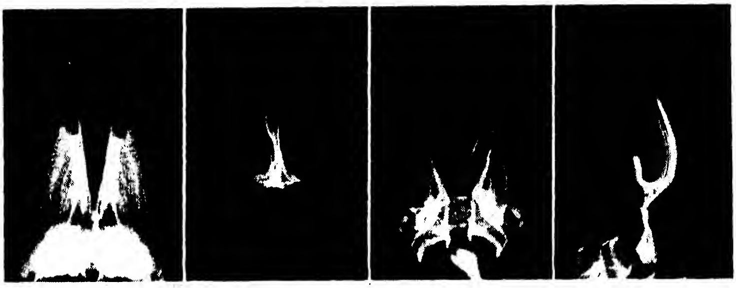
1. O. auronitens — 1a — 1b — 2. O. jucundus

3. O. rotundus — 3a — 3b — 2. O. jucundus

4. O. ritanus — 4a — 4b — 5. O. cocanus

6. O. albonotatus — 6a — 6b — 5. O. cocanus

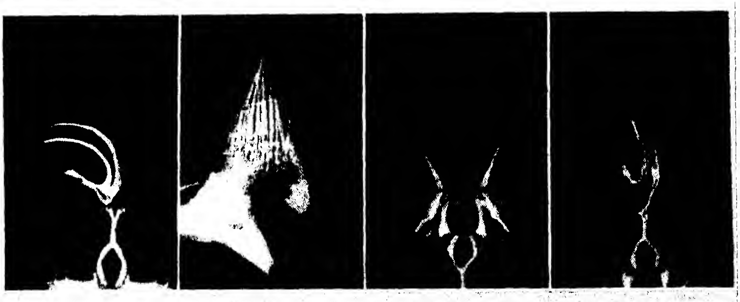
PLATE II.



7. O. unicolor — 7.a — 8. O. ignavus — 8.a

9. O. bifasciatus — 9.a — 10. O. tenuis — 10 a

11. O decorus — 11.a — 11.b — 12. O. clarus



12. O. clarus — 12.c — 13. O. omani — 13.a

PLATE III.

13. O omani

14. O. curvatus

14d

14b

15. O. corniger

15.a

16. O. scalaris

16.a

16.b

17. O. spicatus

17.a

18. O. fumidus

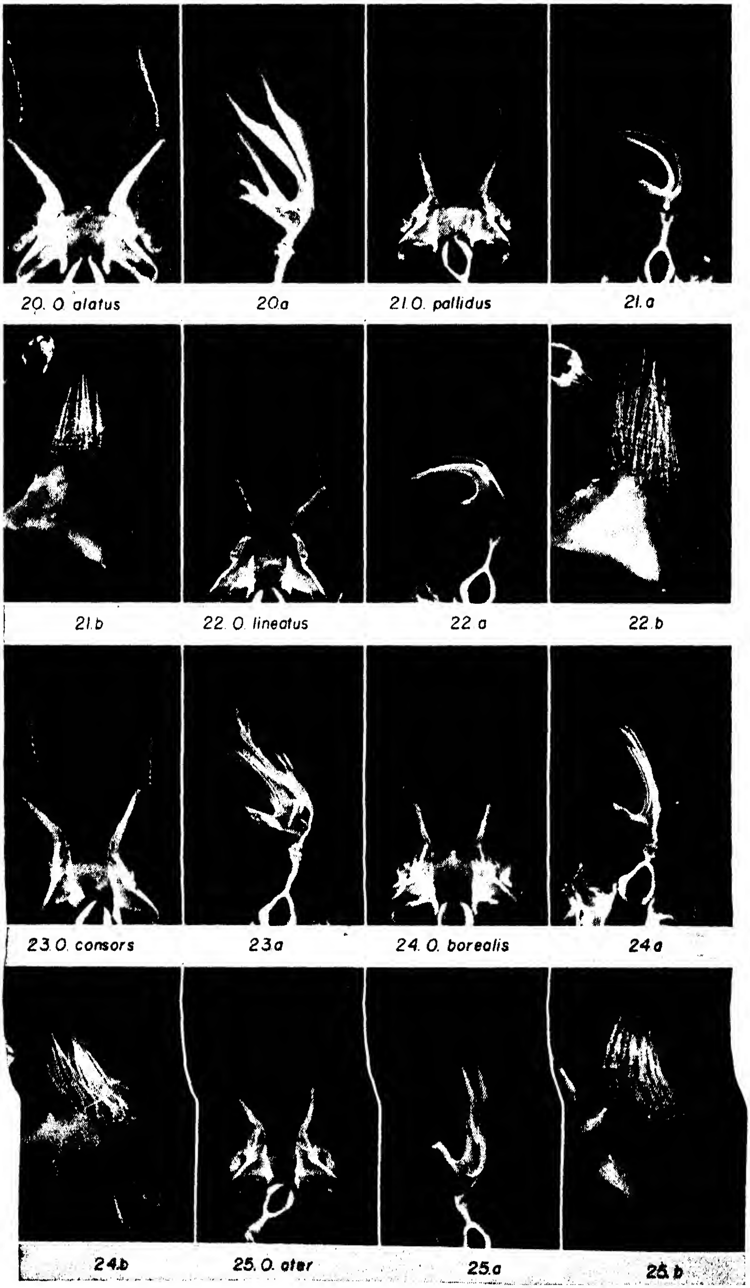
18.a

19. O. mexicanus

19.a

19.b

PLATE IV.


20. O. alatus
20a
21. O. pallidus
21.a
21.b
22. O. lineatus
22 a
22 b
23. O. consors
23a
24. O. borealis
24a
24b
25. O. ater
25a
25 b

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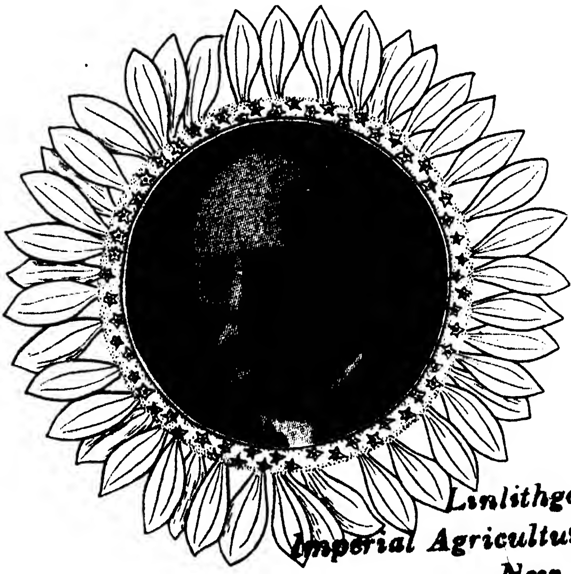

SAMUEL WENDELL WILLISTON
1852 - 1918

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Kansas Entomological Society

Vol. 10, No. 4. October, 1937.

THE SIXTH ANNUAL INSECT POPULATION SUMMARY OF KANSAS COVERING THE YEAR 1936*

ROGER C. SMITH (1) and E. G KELLY (2)

Kansas State College, Manhattan, Kansas

This summary has been prepared with less questionnaire data at hand than has been the case with any of the previous five summaries (3). Returns from the July 1 questionnaire from 12 Entomologists, 18 Vocational agriculture teachers, 22 farmers and from 105 county agricultural agents, together with special survey data on grasshoppers during the outbreak, chinch bugs, and Hessian fly, records from the annual report of the junior author, and the insect pest survey reports of Prof. H. R. Bryson were used in preparing this summary. The October questionnaire was not sent out, through a misunderstanding. The summary maps are not sufficiently complete to justify publication, but they are preserved in the department files for consultation.

Summary of the Weather in Kansas for 1936 (4)

The year 1936 opened with severely cold weather and more snowfall than usual. A cold wave began on January 15 and continued with considerable sub-zero weather until February 21. This long, uninterrupted cold interval set a record for length in some parts of the state.

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*Contribution No. 451 from the Department of Entomology.

This paper embodies some results obtained from investigations on Project No. 6 of the Kansas State Agricultural Experiment Station.

(1) Profesor of Entomology and Associate Entomologist, Kansas State Experiment Station. Absent on sabbatical leave May 1, 1936 to January 15, 1937. The questionnaires were summarized by Mr. Merle Dwd, an N. Y. A. employee.

(2) Extension Entomologist.

(3) The last two, for 1934 and 1935, have been published in the Transactions of the Kansas Academy of Science, Vols. 38 and 39.

(4) Summarized from the monthly reports of S. D. Flora, U. S. Department of Agriculture Weather Bureau, Climatological Data, Kansas Section, Vol. 50, Nos. 1 to 13, 1936.

In many cities and towns water pipes froze to a depth never before experienced.

March had less moisture than fell this month "for 50 years except one, making the first three months of 1936 the driest three-month period on record. The temperature has averaged milder only seven times in 50 years, but has had as much sunshine in only a few years." Dust storms were frequent in the western half of the state.

Drought conditions prevailed in April until rains on the 20th and 26th gave some temporary relief. The first week was one of the coldest on record. The minimum of 8 degrees F. in eastern Kansas and 2 degrees below in the western part did considerable damage to buds.

Heavy rains in May broke the damaging drought temporarily, particularly in the southwestern counties, and brought exceptionally fine growing weather over the entire state. Over the western third of the state it was the fourth wettest May in 50 years. Warmth and a normal amount of sunshine added to the favorable conditions. "Dust storms, which had been frequent and damaging in the western third for more than two years, ended abruptly on May 22."

June came nearly being a record-breaker for deficient rainfall and heat over Kansas. The month had more clear days than any other June for 50 years. Maximum temperature records for the month were broken in many parts of the state, and only the Junes of 1911 and 1933 had less rain.

"July was the hottest month on record except July, 1934, and broke all existing high temperature records in most places. It was the third driest July on record, and completed the driest seven-month period with which any year has begun in more than 50 years." The month brought disaster to the corn crop as one hot dry day succeeded another.

August was the hottest and third driest for the month that Kansas had experienced since the state-wide record was established in 1887. It made the summer of 1936 the driest on record and the hottest the state had ever experienced except in 1934. The eight month period it completed had less precipitation than the first eight months of any year on record. Corn generally had been damaged beyond recovery, and alfalfa had made

little or no growth.

During September more rain fell than in any September, except in 1900, for 50 years. The month was exceptionally warm but decidedly deficient in sunshine. Alfalfa that had not grown any for three or four months and grass in pastures began to grow in the eastern third.

The month of October began with good general rains and about normal sunshine. The month was pleasant and favorable for crop growth. Grass pastures were good.

November was sunshiny and pleasant with deficient moisture—the least, with four exceptions, in 50 years. Wheat showed the effect of dry weather.

December was generally mild, with more rainfall than usual. Christmas Day was the warmest in the history of the state. The rains in September, October, and December put sufficient moisture into the upper soil to carry wheat through the winter.

The summer of 1936 was the driest on record in Kansas as well as in six other mid-western states—Illinois, Missouri, Oklahoma, Nebraska, and the Dakotas. The good rains which fell in Kansas in early September came too late to improve the corn crop materially. However, they put the ground in good condition for fall plowing, fall seeding, and fall forage crops. The closing of August marked the end of one of the most disastrous crop seasons in the history of the state. The drought centered in Missouri, Kansas, and Oklahoma. New high records for temperatures were established, and rainfall was less than one-third normal for the three summer months.

Explanatory Notes on the More Striking Insect Activities in Kansas during 1936

Ants were more troublesome than usual during 1936, the yellow ants apparently increasing as a house and basement annoyance. The kafir ant or "thief ant," which sometimes damages planted seed of kafir and corn, was scarce.

The mound-building prairie ant was reported destructive to alfalfa at Oakley, Brewster, Gem, and Beverly during the summer but it was plentiful in all western areas. Pharaoh's ant was more abundant in 1936, and was rated at 2 in the eastern half and 1 [5] in the western

(5) An explanation of the scorings or rating of the populations on the basis of 0 to 5 is given in the previous summaries. The same concept value is used in this report.

half of the state.

Aphids of all kinds were scarce throughout the spring and summer. In the fall a few species became abundant.

The cucumber and melon aphids were plentiful in June and July, and required treatment in most eastern and middle counties.

Pea aphids were not found in alfalfa fields of the state until late April. Alfalfa made less growth than usual up to April because of the cool dry spring, but there was a good growth by this date in the southern part of the state.

A three-day pea aphid survey on April 23-26, 1936, west and east of Manhattan resulted in the finding of three pea aphids—two wingless ones south of Lawrence and one winged one. This insect has not been so scarce in Kansas since 1920. Moisture, temperature, and alfalfa growth were all favorable to a large outbreak and severe damage, but the species was presumably destroyed in the state by climate conditions and natural enemies during the summer and fall of 1935. Pea aphids were reported injuring garden peas at Ozawakie in June, and some were on peas in Pratt in June. They were rated at 1 in Area 9, 10c, and 1, (6) and at 0 for the rest of the state.

Corn leaf aphis became plentiful on soybeans in late August and September, being rated at 2 for most of the state.

There were few aphids on apple, plum and other fruit trees. Aphids on currants and gooseberries were scarce. They were plentiful on roses in May and June.

Green bugs (Toxoptera) were absent during 1936 in Kansas. This aphid was quite plentiful on fall-sown and volunteer oats in the late fall of 1935. The cold winter of

(6) The map of the crop areas of the state which are here referred to by number was included in the summary for 1931. Jour. Kan. Ent. Soc. 5(3):72, Fig. 1, 1932. The extension department now divides 6 into 6a which includes Cloud, Ottawa, Saline, Clay, Dickinson, and Marion counties; 6b which includes Rice, McPherson, Reno, Harvey, Kingman, Sedgwick, Harper and Sumner counties. Crop area 10 is divided into 10a consisting of Gove, Trego, Lane, Ness and Hodgeman counties; 10b of Stanton, Grant, Haskel, Gray, Ford, Morton, Stevens, Seward and Meade counties; and 10c of Clark, Comanche, and Barber counties.

1935-36 killed most all of them. There was hardly a specimen to be found in the fields in the early spring. It might also be said that there were no oat plants living. An infested spot of wheat about 10x20 feet was found in a wheat field at St. Marys on April 20. Mr. A. L. Clapp also reported this insect damaging barley near Iola.

Bagworms on evergreen and other trees. Eggs were plentiful during the winter of 1935-36 and hatched well in May. There was little damage, and by late summer and fall there seemed to be few full-grown bags on the trees. This pest was rated at 2 in the eastern half of the state.

Biting flies (Stomoxys and Haematobia) were plentiful in May but diminished as the dry weather progressed. By July there was hardly a fly to be seen. The flies returned in late September after the rains to cause much annoyance to livestock. The fine warm days in late September and early October were favorable to their development. There was no serious outbreak, but the flies were plentiful all over the state, being rated at 3 for most of the state.

Blister beetles of several species were abundant all over the state. The beetles attacked garden crops early in June and continued to attack the gardens until late October. Numerous coarctate larvae were found in grasshopper egg pods and others near their so-called egg beds while digging for eggs in the egg survey in October and November, 1935, as well as in the early spring of 1936. Judging from reports and observations made by the Extension Entomologist, some blister beetles occurred in "outbreak" numbers in July and August. The beetles were especially injurious to potatoes, tomatoes, and other garden crops, and also to soybeans and sweet clover. Blister beetles were rated at 5 for most of the state.

Horse bots. During the winter of 1935-36, numerous farmers treated horses for bots, but in Jackson County, horses were reported to have died as the result of bot larvae in their stomachs. The treatment did not include all the animals in a community, and therefore the flies were plentiful again in the late summer and fall. The adults were unusually numerous in September and October at wheat seeding time.

The nose bot was reported in five of the northwest-

ern counties, and the common bot was found in every county of the state. When the farmers began sowing wheat and getting lands ready for wheat-sowing, the bot flies seemed to appear in swarms. This insect was rated at 4 for the state.

Horse flies (Tabanids). There were not many of these flies this year. Usually these biting flies are numerous along the creeks and in the areas of swamps. Plans had been made to build some large fly traps, but there were not enough of the flies to demonstrate the trap. This insect was scored at 3 for areas along rivers and creeks and 1 for uplands.

Borers of several species continued to be major problems in fruit and shade trees. The flat-headed apple tree borers were abundant on apple and other trees throughout the state. The high infestation resulted from the weakened condition of the trees due to drought, heat, red spider, and aphid injuries during the last three years. They were observed in elm and apple trees in eastern Kansas in April and May. The borers were the source of numerous requests for aid from all parts of the state. They attacked apple, plum, peach, and cherry of the fruit trees, and elm, walnut, maple, hackberry, linden, oak, and many others of the shade trees.

The borers were more prevalent in 1936 than in any year known to the writers, many trees producing upwards of 200 larvae. The borer infestation may have been influenced by the moist May and dry June and July. They have been scored at 5 for most of the state.

Box elder bugs were exceptionally scarce during the fall and winter of 1935-36, and few were reported in the spring of 1936. Some were observed on stone or brick buildings as they emerged from hibernation. They were rated at 1 for the most of the state.

Canker worms emerged later in the spring than was the case during the two or three previous years. A few emerged about January 15 at Manhattan, but the main emergence began about February 23. Some banding was done in December and January. Warm weather, which began about February 22, brought out fall canker worms. The soil was dry and the weather too cold for early emergence. The prediction that the winter mortality of pupae would be high was correct, for there were few canker worm moths caught on the bands any time at any

place in the state. By April 20, very few canker worm moths had been caught on the bands at Manhattan. The emergence was the lightest for about five years. Apparently the hot dry summer of 1935 and other factors reduced the population to below normal. This condition prevailed over the state.

In the late fall of 1936, publicity on banding trees to catch the few remaining moths resulted in a widespread application of the remedy, and the catch was light even though December was moist and unusually warm. Indications are that the pest is at a low point in population. A rating of 1 in Areas 1, 2, 3, 5, and 6a, and 0 for the rest of the state has been given.

Cattle grubs were abundant in cattle in every county in the state during the winter of 1935-36. Numerous farmers removed the grubs by squeezing them out. Some reported removing as many as 385 grubs from one animal, and 80 to 90 were common in reports made by farmers and observations of the Extension Entomologist.

Cattle grub flies emerged early in spite of the cool dry spring. Cattle were observed running from the flies the latter part of February in Geary County. Many were also seen hiding in bushes along fences on April 14 in Dickinson County. The flies were observed chasing cattle in Jackson County on April 10, at Anthony, Manhattan, and Wellington on April 6, and in Bourbon County about the middle of May. These dates and locations indicate that the heel flies were out early and continued to be abroad well into May.

A survey of cattle by the Extension Entomologist and county agents in ten eastern and five central counties indicated the grubs in cattle in the fall of 1936 were not as numerous as in the fall of 1935. In fact, while locating some demonstrations in these counties it was difficult to find calves or cows with as many as 25 to 30 grubs in their backs, and most of the animals examined were practically free of the pest. The rating of 4 was given for most of the state.

Cattle lice, both chewing and sucking, were more plentiful and destructive during the spring of 1936 than for several years. Some cattle died in Geary and Pottawatomie Counties during January and February from heavy infestations of sucking lice. More requests for information for control of lice on cattle and horses reach-

ed the Department of Entomology than usual. The excessively cold weather during January and February made dipping or spraying operations dangerous and difficult.

Horses and cattle in Sumner, Harper, Pratt, Pawnee, and Reno Counties were reported heavily infested in the early spring. The long-nosed ox louse was plentiful in Harper County in early April. A rating of 4 was given for most of the state.

Cutworms. Army cutworms were exceptionally scarce during the spring all over the state. Mr. H. H. Walkden made a 1500-mile survey trip to the southwestern part of the state and found practically none. They were the scarcest for many years.

A three-day survey in Kansas April 14, 22, and 23 resulted in finding only two or three larvae. Many larvae of **Feltia subgothica** (the dingy cutworm) occurred, but this is a species of little economic importance. A field south of Junction City had an average population of four to the square foot, but no injury was done. The population of this species in northeastern Kansas was the largest in recent years, while the army cutworm had the smallest.

The pale western cutworm was abundant in scattered areas in central and western counties in May. Considerable wheat was damaged in Rush, Sheridan, Rawlins, Edwards, and Kiowa Counties. In early May they appeared in many wheat fields of western Kansas and especially in a small area of about five counties of which Barton County was the center.

The variegated cutworm appeared quite early in February and March in wheat fields in southern Kansas.

In the early fall the fall armyworm appeared in many wheat fields, feeding on the volunteer wheat. They seemed to disappear before the planted wheat came up. The rating for cutworms was set at 3 in Area 9, 7, 10a, and 11, and 1 for the rest of the state.

Chinch bugs. The chinch bug survey made in the fall of 1935 indicated there was a large population of bugs in about 38 to 40 counties including Harper, Harvey, and Clay as western boundaries. The spring survey, made in late April and in May, indicated there would be many bugs moving out of wheat and barley to corn in this area, and that creosote-cyanide barriers would be needed. The

winter survival was high from moderately large numbers over-wintering.

The bugs began moving from wheat and barley quite early in June on account of the very dry weather. Reports from 36 county agents in the eastern half of the state indicated 5,344 farmers built and maintained more than 2,500 miles of creosote-cyanide barriers to protect about 300,000 acres of corn and soybeans. They were rated at 5 in Areas 1, 2, 3, 4, 5, and the east half of 6b, and 1 in the west half of 6b, 9, 6a, and 8.

Codling Moths in the apple districts of the state built up from the low carry-over of last winter. A third brood was present this year, whereas only two broods were present last year.

Corn rootworm. This is a pest of major importance in the northern tier of counties, but it has been scarce during the last few years—probably on account of the drought.

Corn bill bugs were scarce in southern Kansas, where they usually occur.

Crickets. The common black field crickets were more numerous during the summer and fall than usual. They caused considerable annoyance in basements and houses. A heavy population was observed along a one-half mile stretch in Mitchell County on August 6. They were reported being a nuisance in a store in Osage County. The excessive heat and drought drove them to basements where they became a nuisance. Reports came from all parts of the state that crickets were in the basements of houses. They were rated at 2 in most of the state.

Cucumber beetle. The striped cucumber beetle was abundant early in May, and continued to be destructive until late June. The second generation appeared to be less numerous. The beetle attacked cucumbers, melons, and squash plants in all parts of the state, but seemed to cause more trouble in southeastern Kansas. They were rated 4 in most of the state.

The spotted cucumber beetles were not a pest on cucumbers in May and June, but were serious on garden flowers, especially zinnias, in September. They were rated 3 in gardens for most of the state.

Flea beetles were plentiful on radishes, turnips, and eggplant in April, but there was little damage. They were reported from the south-central counties.

House fly. This house pest was plentiful early in the spring, but became rather scarce as the weather turned dry. In the late fall, after the rains, the flies became annoying. They were rated at 3 for most of the state.

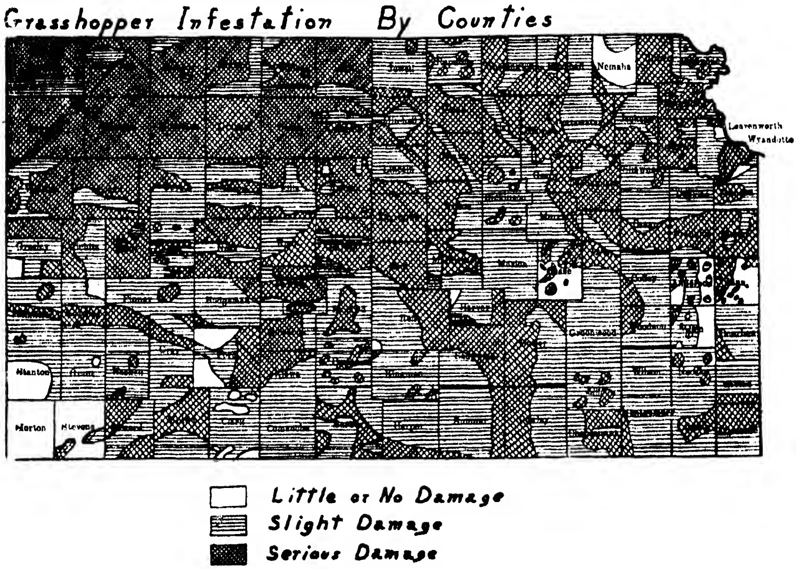

Fig. 1. The grasshopper outbreak in Kansas, 1936, as reported by 101 county agents in August. No one agrees completely with this map but in general it is correct. It shows the spotted nature of the outbreak.

Harlequin cabbage bug was reported from a few localities as being plentiful, but no serious damage was done by it.

Grasshoppers. The outstanding insect feature of 1936 was the unprecedented, statewide, outbreak of grasshoppers which has been designated by many observers as excelling the outbreaks of the early 70's. Grasshoppers have been scored at 5 for the entire state for the year, with the exception of Stanton, Morton, and Stevens counties which are scored at 3.

The grasshopper survey during the fall of 1935 revealed a larger number of eggs than usual. Estimates of needed bran mash for 1936 were made on the basis of a severe outbreak. The winter of 1935-36 was ideal for the eggs because cold weather continued from early De-

cember to the end of February without thaws. There were some good rains in May and the moisture brought out the young hoppers. The rains ceased in early June, the weather turned dry and hot. Grass and weeds either died or became unattractive so the hordes of young hoppers attacked cultivated crops.

In Riley county the young hoppers appeared about one month earlier than normal and went first into the wheat fields after which they attacked oats and then corn. Alfalfa, sweet clover, and other legumes were attacked continuously from the time of hatching and most eggs were laid in the fall in or around the margins of alfalfa fields. Corn over most of the state was severely attacked or destroyed. Weeds were quite generally fed upon. Kafir and other sorghums were not injured severely. Both the tops and bulbs of wild and cultivated onions were completely devoured in nearly all parts of the state. Pastures were benefitted by the removal of wild onions. Farmers observing the attractiveness of onions to hoppers have since used chopped onions and onion juice in baits. This is perhaps a first report of hoppers eating onions.

A special feature of the outbreak was the behavior of the hoppers with relation to the excessive heat. The surface of the soil was so hot that the hoppers spent most of their time up in the trees, the tops of weeds, corn, or in other tall plants. They did not come down to the ground to feed as the great majority of them usually do. This complicated the sowing of the poison mash. Some unsatisfactory results with the mash were due to the hoppers refusing to leave their high roosts. Mash was thrown up into the corn plants and it was common to find several dead hoppers with their heads buried in the axils of the leaves.

There were many reports to the effect that bran mash was not giving satisfactory control. Heavy kills were obtained but failures in controlling the grasshoppers were in some cases due to their refusal to come to the ground to feed, in others to migrations from adjacent fields, or to flights from more distant fields, and to the excessive heat which dried out the mash quickly. Some nurserymen made as many as 12 to 20 sowing of mash to protect their nurserystock. More than 550 alfalfa growers reported using hopperdozers and hopper catchers.

Their value in grasshopper control under conditions in Kansas in 1936 was demonstrated conclusively.

Prof. Wilbur reported that the differential grasshopper was the dominant species in the outbreak even in western Kansas. Dr. Woodruff reported that the red legged species was dominant around Lawrence. The migratory species was abundant, but the two lined ranked third.

The grasshoppers damaged or destroyed corn and alfalfa extensively. Some fields which were saved by hopper control methods were later rendered valueless by the extreme drought. Many trees, not only isolated shade trees and hedge rows, but varieties of woodland and park trees were defoliated. Many apple trees had severe foliage damage and even the next year's fruit buds were eaten as was shown by absence of bloom in some orchards during the spring of 1937. Many shade trees had the bark completely removed. In some cases the hoppers ate pits in the bark, and in other cases the bark was removed in large patches. Reports of damp clothes on the line being eaten by hoppers, of coats or other clothes being destroyed on the ground have been made.

Professor Dean observed the differential and migratory species fly as far as 5 miles to other fields. There were definite migrations from grasslands and wheat stubble to corn and alfalfa fields throughout the season. Heavy flights occurred into towns where gardens, trees and ornamental plantings were damaged.

A feature of the outbreak was the heavy parasitism by sarcophagid flies chiefly **Sarcophaga kellyi.** The flies first appeared in May but they were largely inactive during the hot, dry summer. They reappeared the latter part of August, when rains came, and destroyed large numbers of hoppers. Great numbers of the larvae and puparia were taken in the hopper catches at the college farm and reared to adults.

In most of the counties in northeast Kansas during the latter part of May, the fungus disease was present. Professor Dean observed young hoppers dying of the disease in many sections. If the rains had continued for two weeks in June, the disease might have brought about control.

Relatively few eggs were laid in the early fall compared to the number of hoppers present during the year.

Professor Wilbur found few eggs of grasshoppers in the survey conducted in September and October except in northeast Kansas. He believed that the weather was too hot for the development of the gonads or that there was insufficient nutritious food for the development of the eggs.

Another feature of the outbreak was that the large population of adults did practically no damage to fall sown wheat and alfalfa. Only wheat sown in August and early September for pasture was damaged by grasshoppers while wheat sown at the fly safe date escaped injury. Less than usual fall damage was done and not a single report of damage to young alfalfa was received. There was little or no injurious feeding after the first week of October.

The following sentence summaries were prepared by the extension entomologist and assist in portraying the extent and severity of the outbreak:

Alfalfa treated with a dozer in 61 counties—30.769 acres.

Soybeans treated with a dozer in 15 counties—648 acres.

Farmers in 79 counties bought 55,120 pounds crude arsenic.

County commissioners in 30 counties bought 82,000 pounds crude white arsenic.

Federal Government allotted 96,600 gallons sodium arsenite to Kansas.

County commissioners in 10 counties bought 2,905 gallons of sodium arsenite.

Wheat bran purchased by farmers in 93 counties—7,793,500 pounds.

Wheat bran purchased by county commissioners in 23 counties—1,788,700 lbs.

Molasses purchased by farmers in 79 counties—85,575 gallons.

Mixed bait furnished by Federal Government in 1934 left over in 9 counties—85,792 pounds.

Wheat slightly damaged in 69 counties—1,375,990 acres.

Wheat seriously damaged in 23 counties—82,426 acres (not harvested).

Oats slightly damaged in 61 counties—390,090 acres.

Oats seriously damaged in 18 counties—23,307 acres (not harvested)

Corn slightly damaged by grasshoppers in 75 counties—1,449,945 acres.

Corn seriously damaged by grasshoppers in 88 counties—1,471,155 acres.

Barley slightly damaged in 45 counties—132,445 acres.

Barley seriously damaged in 17 counties—11,982 acres (not harvested)

Orchards seriously damaged in 60 counties numbered 3,746.

Gardens seriously damaged in 95 counties numbered 83,848.

Alfalfa slightly damaged in 79 counties—341,095 acres.

Alfalfa seriously damaged in 73 counties—213,935 acres.

Osage orange hedge defoliated in 64 counties—15,277 miles.

Farmers using Federal sodium arsenite in 104 counties—42,487 (all except Norton).

Farmers using white arsenic furnished by county commissioners in 38 counties—18,500.

Farmers purchasing white arsenic or sodium arsenite in 88 counties—17,274.

Total number individual farmers using poison bait—54,314.

Hessian fly. In the fall of 1935 the Hessian fly appeared to be building up in numbers. There were many heavily infested fields in the southern and central counties. Several thousand acres were so badly damaged by the fall infestation that the fields were planted to other crops in the spring of 1936. The number of flaxseeds on the plants in the spring indicated there would be a heavy infestation; however, something happened to the adults

or eggs in April, for after the hot dry days, during which time most of the adults were abroad, there were very few living maggots on the plants. The insect had suffered a severe reverse on account of hot dry weather, and the infestation in the stubble was even lighter than it was in 1935. In a small area centering in Geary and McPherson Counties there were more of them living than in the eastern counties. A few were found in all fields visited in Doniphan County the latter part of April.

The Hessian fly devastated nearly every field in southeastern Kansas which was planted before the fly-free date in the fall of 1935. As much as 66 per cent of the plants were infested in December at Iola. While many farmers ascribed the loss to winter killing, they learned that the fly caused the loss. The population was estimated at an average of 5 per plant.

Mr. F. E. Davidson reported April 20 only a light infestation of flies at Columbus, Kansas, in spite of the fact that much of the wheat was planted early. An area around Parsons for eight or ten miles was reported as heavily infested, as was also an area west from Erie towards Chanute, and then well over into Wilson County where the wheat was damaged rather badly by the fly.

The Hessian fly population in Dickinson to Cowley counties was almost wiped out by temperatures from 16 degrees F. to 20 degrees F. in early April. The pupa and adults were destroyed, leaving the wheat almost free. Remaining live plants made a good comeback after the rains the latter part of April and early May.

Adult flies were observed laying eggs, three to ten per leaf, in Jackson County April 13, and south to Wilson County during the next few days. The hot winds and dry weather that followed seemed to have prevented the eggs from hatching.

The fall infestation was also light in all eastern counties. They were rated at 2 in Areas 1, 2, 3, 4, and 5, and at 1 in Areas 6a and 6b.

Mites and Ticks

Brown mites occurred in a few spots of damaged wheat in the fields of the southwest counties. These spots were in fields where the stubble had not been covered. There were a few fields slightly damaged at the

edges by the mites moving from stubble into the fields as is a well-known habit of the chinch bug.

Mange mites on hogs. The hog mange was less troublesome this year than for many years.

Sheep scab mites. Kansas has been fairly free from sheep scab mites for several years. The Federal quarantine has been effective in keeping them out of the state.

Dermacentor nigrolineatus, a common and more or less harmless species of Texas tick, was taken in large numbers on a herd of cattle shipped to Lebo, Kansas from Texas in January. The tick was identified by Dr. F. C. Bishopp, who stated that this species of tick had been unable to establish itself in Kansas and more northern states, presumably because of the cold winters.

Spinose ear ticks were reported to be plentiful, especially in western Kansas, during the winter of 1935-36 and again in the fall of 1936. They were rated at 1 for the state.

. . . .

Screw worms were scarce this year due in a great measure to the Federal inspection of cattle coming into the state. The range or pasture cattle were watched very closely and protected. This pest was rated at 1 for the state.

Mosquitoes were exceptionally scarce in Kansas during the year. Some localities reported some annoyance from them, but not as much as usual. They were present about the first week in October, after almost a complete absence during the summer.

Negro bugs (Thyreocoria publicarius Germ.) Negro bugs were numerous this year, but apparently did not cause appreciable injury.

The onion plant bug (Labopidea allii Knight) damaged onions all over the state during May as was observed by R. H. Painter.

Rose curculio (Rhyncites bicolor). This insect was more abundant during 1936 than has been observed or recorded before at Manhattan. Cultivated roses were attacked.

Squash bugs appeared early. By August the young bugs were abundant and attacking squashes and pumpkins which had escaped the drought doing severe and widespread injury. They were rated at 3 for the state.

The common stalk borer (Papaipema nebris) was reported injuring tomatoes at Brookville and White City, corn at Leavenworth and Clyde, and potatoes at Mulberry. They were rated at 3 for the eastern half of the state.

The strawberry leaf roller (Ancylis comptana) was abundant in northeast Kansas in the vicinity of Troy and Wathena in June, and the strawberry saw fly **(Harpiphorus maculatus)** completely defoliated the plants on two farms at Wathena. The strawberry leaf roller was plentiful in May in Most eastern Kansas counties. They were rated at 2 for the eastern third of the state.

Termites swarmed in large numbers on May 2 following the excellent rains of April 30 and May 1 in eastern Kansas. Many requests for information about termite control were received, but this was in large part due to the activity of termite treating companies and the spread of information through radio and press about these pests. Numerous houses have been found to be infested, and more reports of living trees being infested than have ever before came to the notice of entomologists. Both large as well as small trees have been killed by termites. These insects have been rated at 4 for the state.

Mr. W. A. Talbott, Jr. of the Underhill Terminix Company of Wichita, a state-wide operator in termite control, reported to the authors, from the records of their inspection service, the following data for the year 1935:

"In 69 counties a total of 2,635 inspections were reported.

Buildings infested	1,653
Ground infestations	201
No apparent infestations	766
Powder post beetles	15

"It might be concluded that termite-infested buildings represent 62.7 per cent of the total number inspected and reported." This cannot be taken as the actual percentage of infestation for the state since the company representatives, for the most part, are primarily concerned with the infested properties and inspected many houses on request.

"The damage, however, in the infested buildings was found to be serious. In the city of Wichita the termite damage annually exceeds the fire loss, and this is probably true in many other cities in the state.

"Infestation is not uniform over the state. Some areas show slight infestation, and in others it is quite heavy. As yet, complete information regarding the state is not available."

Tarnished plant bugs attained normal numbers in the alfalfa fields in the early spring. Young bugs hatched in the fields about April 22. By October 20, they were more abundant than last year but still scarce. They were rated at 2 for the eastern half of the state.

The wheat stem maggot (Meromyza americana) was more abundant in the state than usual in June. They rated 1 for the central and eastern part of the state

Wheat straw worm. This species has been abundant for several years, but appears to have become scarce during the drought years.

False wireworm. This insect caused slight damage in the fall of 1935, and required some attention in the season of 1936. Some fields near Conway Springs and Wellington were seriously damaged. Four fields near the latter city and six at Anthony were abandoned because of this pest, chiefly **Eleodes opaca** and **E. suturalis.**

In the late fall the false wireworms were abundant in western and southwestern Kansas, but caused little injury to fall-sown wheat. In most localities, sufficient rainfall was received to insure fairly rapid germination of the seed, and therefore little injury occurred. One report of injury was received from Meade County. The insect was rated 4 in Areas 6b, 9, 10a, and 10b, and 3 in Areas 6a and 7.

Wireworms (Melanotus) were observed by Prof. H. R. Bryson to have been less plentiful in March than usual.

Grain weevils were scarce in wheat because there was little wheat left in storage on the farms and not much in local elevators. There is some rather badly infested sorghum seed which was kept over for planting.

Dr. R. T. Cotton of the local field station of the Bureau of Entomology and Plant Quarantine reported that, "Inspection records of carloads of grain arriving in Kan-

sas City, Missouri during the past five years present an excellent picture of the condition of stored grain in the southwestern grain producing area from the standpoint of insect infestation.

"It is interesting to note that there has been a steady decrease in the number of cars infested with weevil, each year during this period. The record for the past year of 1936 is most remarkable since of the 36,585 carloads of grain inspected only 86 were found to be 'weevily'. During no month of the year did the infested cars equal one per cent of the total number inspected, and during July, of the 18,448 cars inspected only 2 were found "weevily'.

The steady decrease in infestation has undoubtedly been due to the succession of dry, hot years experienced in this area. Grain crops have been small and there has been no large carry overs. The newly harvested grain has been low in moisture and during the past season has gone into storage with a moisture content of about 9 per cent. Since investigations have shown that most insect pests of stored grain are unable to breed in grain with a moisture content of less than 10 per cent, the freedom from insect infestation is not surprising."

Poultry lice were plentiful in April and May, and poultry required treating. They were rated at 3 for the state.

White grubs in general caused little injury in 1936. and required no immediate attention. They were less plentiful at Manhattan than one might expect following the beetle year. Dead grubs found in March in the upper six inches of soil appear to have been killed by freezing.

Wheat white grubs caused considerable injury to one field of wheat at Manhattan. A report from Hazelton indicated that the wheat white grub, **Phyllophaga lanceolata,** had cut off wheat plants in several fields in that vicinity. White grubs were also active in strawberrry beds in northeast Kansas. They were rated at 3 in Areas 6b and 9, and 2 in Areas 5 and 6a.

Webworms were present in a few alfalfa fields in July along the Smoky Hill and Kaw River Valleys and a few in the northeast. There was no damage by the insect on account of poor growth of alfalfa in July. They were rated at 1 only for the state.

Summary

The weather during 1936 was characterized by marked drouth during the spring and summer up to the latter part of August and record breaking high temperatures from early June to the latter part of August. It was a poor crop year though a good crop of wheat was harvested and the fall weather was ideal for crops.

The following insects occurred in **outbreak** numbers during 1936; grasshoppers—an unprecedented outbreak with widespread damage which is the chief insect feature of the year, blister beetles, and borers.

The following insects were **scarce or without consequence** during the year; aphids, horse flies, box elder bugs, canker worms, cutworms, chinch bugs, cucumber beetles, hessian fly, mange mites, screwworms, mosquitoes, wheat straw worms, and grain weevils.

The following insects were **more plentiful** than during 1935; ants, blister beetles, borers, cattle lice, chinch bugs, codling moth, crickets, cucumber beetles, grasshoppers, onion plant bugs, rose curculio, squash bugs, strawberry leaf roller, wheat stem maggot, and webworms.

The following insects were **less plentiful** than during 1935; aphids, biting flies on live stock, horse flies, canker worms, cut-worms, house flies, mange mites, screw worms, termites, false wireworms, wireworms, grain weevils, hessian fly and white grubs.

PSEUDOMASARIS OCCIDENTALIS (CRESSON) IN KANSAS (HYMENOPTERA-VESPIDAE)

H. B. HUNGERFORD, Lawrence, Kansas*

Vespid wasps, as a rule, provision their nests with other insects (mass provisions) or feed insects to their larvae from time to time (progressive provisioning). There are, however, some wasps of the family Vespidae that provision their nests with pollen and nectar after the fashion of bees. In North America we have the genus Pseudomasaris which does this. According to Doctor Bequaert[1] there are "14 species in the western United States, from the southern part of British Columbia to Lower California and eastward to Colorado and Texas." The finding of **Pseudomasaris occidentalis** (Cresson) in southeastern Kansas is therefore an interesting new record for the state. This species was described from Texas and so far as I know there are no published notes on its biology.

While European workers have long ago reported that masarid wasps provision their nests with pollen, it has been only within the past ten years that the same habit has been demonstrated for any of our species. Hicks[3] in 1927 found nests of **Pseudomasaris vespoides** (Cresson) attached to rocks and consisting of from 2 to 13 cells. These cells were mass provisioned with pollen and plugged with caps that had cup-shaped depressions.

The depressions, first reported by Davidson[2] in 1913, were thought at the time to be for the purpose of catching rain and softening the material for a more successful emergence from the exceedingly hard cases. In 1929 Hicks[4] recorded the pollen provisioning of **Pseudomasaris edwardsii** (Cresson) which also attaches its extremely hard nest to rocks, and gave additional notes on **Pseudomasaris vespoides** (Cresson). Some nests of the latter species were found attached to plants. Specimens emerged successfully from dry cells. From the nests of **Pseudomasaris edwardsii** (Cresson) he reared a male mutilled. **Chrysis densa** Cresson was reared from nests of both species of Pseudomasaris.

The nest of **Pseudomasaris occidentalis** (Cresson), attached to a fragment of limestone rich in calcite

*Contribution from Department of Entomology, University of Kansas.

crystals, was sent to me by Mr. John Mitchell. He reported the nest to have been found in the Lee Hunt cement quarry on Table Mound, near Independence, Kansas. The exceedingly hard rock-like texture of the nest suggested to him that it was made of cement, yet the cement plant had been closed for thirteen years and he desired some information concerning it. The nest was collected and sent to me on May 4, 1936, and there emerged from the five cells on May 12, 1936, two males and one female of **Pseudomasaris occidentalis** (Cresson)* and two parasites, **Chrysis densa** Cresson*. These insests had no difficulty in making their exit through the very hard stone-like nest. The cells were laid down side by side and their contour visible from above. They are made of limestone sand, some of the calcite grains measuring an eighth of an inch in diameter. Some more finely ground material was used to partially fill the depressions between the cells. The caps did not show the cup-like depression described for **Pseudomasaris vespoides** (Cresson). The two parasitic wasps emerged from the end cells, one of them through the anterior end and the other through a break in the side of the cell caused by loosening the rock fragment from the ledge. Each cell contained at its lower end a mass made up of many pellets. Professor W. C. Stevens, of our Botany Department, examined one of these masses and found it to be made up of pollen grains. We are thus able to report a pollen provisioning wasp for Kansas.

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*Footnote. These were kindly determined for me by Dr. J. Chester Bradley of Cornell University.

INSECTS FOUND IN THE MILLING STREAMS OF FLOUR MILLS IN THE SOUTHWESTERN MILLING AREA.

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INTRODUCTION

The adoption of modern methods of insect control has materially changed the relative abundance of certain species infesting the milling streams of flour mills. Formerly the Mediterranean flour moth (**Ephestia kuehnella** Zell.) was the worst insect pest of flour mills, whereas now the flour beetles (**Tribolium** spp.) are the most important. Individual species of flour-mill insects are not equally abundant in all sections of the country, their numbers being influenced by climatic conditions as well as by the methods of control practiced.

In the course of studies relating to insects inhabiting flour mills and stored grain, an opportunity was provided for obtaining data on a large scale regarding the abundance of insects infesting the different mill streams of flour mills in Kansas, Oklahoma, and Missouri. In 1932 and 1934-35, 8-ounce samples were collected monthly from each of 24 elevator boots and other mill streams of 19 selected flour mills in these three States. The insects contained in these samples were sifted out and identified as accurately as was possible without the aid of a microscope, (2) and the numbers of each species and stage, alive and dead, were counted and recorded.(3) The re-

(1). The writer acknowledges his indebtedness to Geo. B. Wagner, of this laboratory, for permission to use data from a monthly flour-mill sampling project which he initiated and in which the writer participated, and for his assistance in the interpretation of certain information presented herein.

(2). A hand lens was frequently used, and specimens that appeared to be of particular interest were sometimes set aside and examined under a binocular microscope. It was easily possible, without a lens, to place practically all the insects in the proper genus and, except in **Tribolium, Laemophloeus, Palorus, Alphitobius,** and a few others, to identify the species.

(3). Information derived from these data, showing the effect of various control measures, or the lack of them, on the total population of insects infesting flour-mill streams, has already been published. See Wagner, G. B., and Cotton, R. T. Factors affecting insect abundance in flour mills. Northwestern Miller, Nov. 20, 1935, pp. 522-523, 4 figures.

cords from 17 of these mills for the period April 1934 to April 1935, inclusive, are tabulated and discussed in this paper. The approximate locations and daily capacities of the mills are shown in the accompanying map (fig. 1).

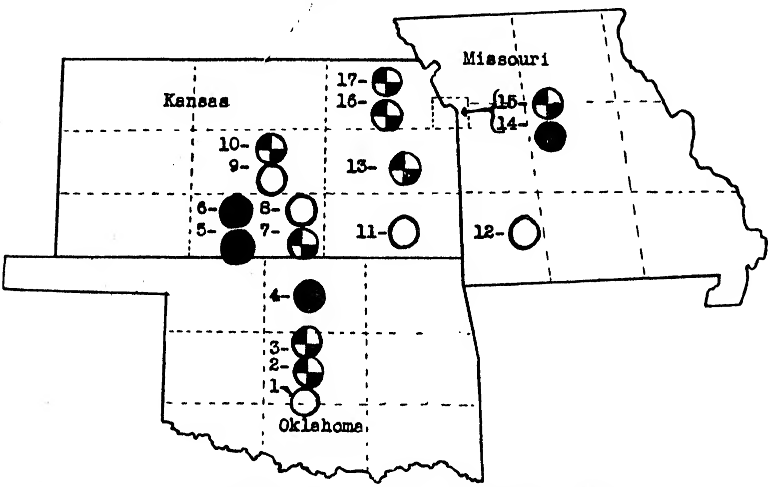

Figure 1.—Map showing location and capacities of flour mills surveyed.
White circles—Mills of less than 1,000 barrels daily capacity.
Black and white circles—Mills of 1,000 to 2,500 barrels daily capacity.
Black circles—Mills of 2,500 or more barrels daily capacity.

RELATIVE ABUNDANCE AND FREQUENCY OF OCCURRENCE

The relative abundance of the six leading groups of insects in all the samples examined is shown in figure 2. The preponderance of the flour beetles (**Tribolium** spp.) is the most striking feature of the chart. The two species (**T. confusum Duv.** and **T. castaneum** Herbst) were not separated when the samples were examined, but it is probable that they are about equally numerous in the territory covered. The flat and the rust-red grain beetles (**Laemophloeus minutus** Oliv. and **L. ferrugineus** Steph.) were second in numbers, followed by the cadelle (**Tenebroides mauritanicus** L.), the lesser grain borer (**Rhizopertha dominica** Fab.), the rice and the granary weevils (**Sitophilus** spp.), and the long-headed flour beetle (**Latheticus oryzae** Waterh.). None of the other species or genera present made up more than

0.22 percent of the total and so cannot be considered of any great economic importance in the region surveyed. Although both **Laemophloeus minutus** and **L. ferrugineus** were present, the former appeared to be considerably more numerous than the latter, while in the genus **Sitophilus** 93.5 percent were identified as **S. oryzae** L. and only 6.5 percent as **S. granarius** L.

Figure 2.—Percentages of the various species or groups of insects taken in mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934-35. (Total, 74,175 insects.)

Almost as striking as the large number of **Tribolium** spp. is the virtual absence of the insect that was once considered the most injurious of all flour-mill pests, **Ephestia kuehniella.**

At least 30 species, distributed among 25 genera, were found in the samples. It is interesting to note that,

of the total of 74,175 specimens collected, all but 112 were beetles; in other words, the Coleoptera made up 99.85 percent of all insects present in flour-mill streams in this region during 1934-35.

The percentage of samples infested with the more important flour-mill insects is shown in figure 3 while table 2 contains data on all of the species concerned. Approximately four-fifths of all the samples collected were infested with from 1 to 1,320 insects. **Tribolium** spp. were found in 78.0 percent of all samples collected, or in 97.1 percent of all samples infested by any insects. **Tenebroides mauritanicus** was present in 17.2 percent, of the samples, **Laemophloeus** spp. in 11.7 percent, and **Sitophilus oryzae** was found in a few more samples than **Rhizopertha dominica.**

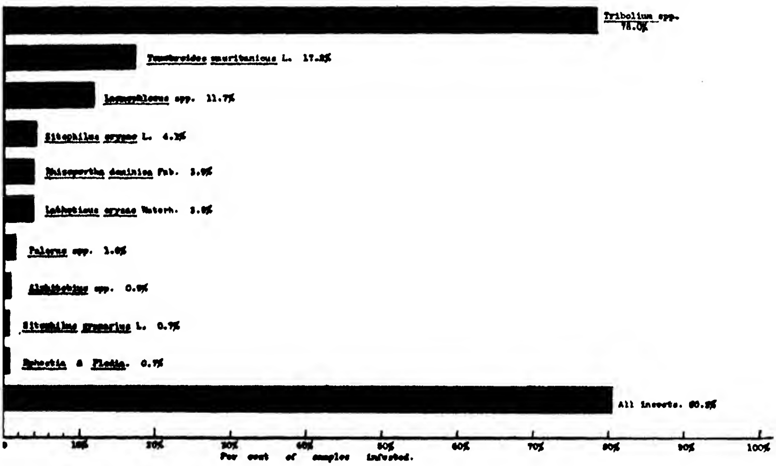

Figure 3.—Percentage of 8-ounce samples from flour-mill streams infested by each of the more important flour-mill insects, as found in 2,367 samples collected from 17 flour mills in Kansas, Oklahoma, and Missouri during 1934-35.

GEOGRAPHICAL DISTRIBUTION

The flour mills discussed in this paper are located within a rather small geographical area, within 200 miles of Independence, Kans. Thus, great variations in the species found, and in their abundance, due to the influence of climatic factors, would hardly be expected. The average annual rainfall ranges from 27.8 to 41.8 inches,

Table 1 -- Abundance of the different species of insects collected in all mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934 and 1935.

Species	Number of specimens found in mill of indicated number and location																	Total
	7	3	9	11	2	12	8	17	6	5	1	10	14	16	15	4	13	
	South Central Kansas	Central Oklahoma	Central Kansas	South-eastern Kansas	Central Oklahoma	South-western Missouri	South central Kansas	North eastern Kansas	South central Kansas	South central Kansas	Central Oklahoma	Central Kansas	Kansas City Area	North-eastern Kansas	Kansas City Area	North central Oklahoma	East central Kansas	
Tribolium spp.	15,431	8,520	6,968	4,939	3,629	2,792	3,512	3,209	3,145	2,665	1,893	1,871	1,604	1,497	466	348	297	62,786
Laemophloeus spp.	3,364	257	91	50	792	316	101	44	73	56	75	482	134	9	0	56	0	5,900
Tenebroides mauritanicus L.	207	381	52	249	210	469	185	3	34	13	96	68	297	62	0	2	23	2,341
Rhizopertha dominica Fab.	649	19	66	38	83	120	16	2	9	74	251	27	2	0	3	13	0	1,322
Sitophilus oryzae L.	109	60	62	76	2	178	53	12	3	19	72	19	3	10	0	0	1	679
Latheticus oryzae Waterh.	0	332	0	0	3	0	0	0	0	0	227	3	0	1	0	0	0	566
Palorus spp.	5	0	1	46	0	47	13	0	1	0	28	16	4	2	0	0	0	163
Oryzaephilus surinamensis L.	0	1	1	0	0	121	5	0	0	0	0	2	0	0	0	0	0	130
Attagenus piceus Oliv.	2	2	0	0	0	6	1	0	1	0	2	37	0	3	0	0	0	54
Alphitobius spp.	0	28	0	3	0	8	4	2	0	0	0	2	1	2	0	1	0	51
Sitophilus granarius L.	0	0	3	1	0	27	4	0	0	0	6	6	0	0	0	0	0	47
Corrodentia	5	7	0	0	1	0	22	0	0	0	0	0	0	0	0	0	0	35
Ephestia kuehniella Zell. / Plodia interpunctella Hbn.	11	0	0	0	3	16	0	0	0	1	0	0	0	0	0	0	0	31
Acarina	0	4	0	0	0	0	10	0	0	0	10	0	0	0	0	0	0	24
Gnathocerus cornutus Fab.	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	14
Hymenopterous parasites	2	2	1	0	0	0	1	0	1	0	4	0	0	0	0	0	0	11
Scenopinus spp.	0	0	0	0	0	1	0	0	0	0	1	0	0	3	0	0	0	5
Pyralis farinalis L.	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Typhaea stercorea L.	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	3
Carpophilus dimidiatus Fab.	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
Corticaria sp.	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
Corticaria serrata Payk.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Anthicus sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Unidentified Coleoptera	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Unidentified Diptera	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Blattidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	19,789	9,615	7,245	5,402	4,673	4,091	3,927	3,272	3,269	2,828	2,666	2,539	2,060	1,589	469	420	321	74,175
Number of samples collected	193	224	186	98	222	143	182	45	175	219	128	126	121	45	100	138	23	2,367
Number of samples infested	187	209	157	96	167	132	151	43	120	160	120	104	100	42	39	55	19	1,901
Percentage of samples infested	96.9	93.3	84.9	98.0	75.2	92.3	83.0	95.6	68.6	73.1	93.8	82.5	82.6	93.3	39.0	39.9	82.6	80.3
Average number of insects per sample	102.5	42.9	39.2	55.1	21.0	28.6	21.6	72.7	18.7	12.9	20.8	20.2	17.0	35.3	4.7	3.0	14.0	31.3

the temperature from 54.2 degrees to 60.3 degree F., and the elevation from 740 to 1,550 feet. The mills range in capacity from 300 to 5,800 barrels per day.

The geographical distribution of the insects found is shown in table 1 and figure 4. There is apparently no relation between geographical location within this area and either the total abundance of insects or the abundance of any of the five leading groups: **Tribolium, Laemophloeus, Tenebroides, Rhizopertha**, or **Sitophilus.** Had the two species of **Tribolium** been tabulated separately, there would probably have been a preponderance of **T. castaneum** in Oklahoma and of **T. confusum** in northern Kansas, since they are the predominant forms in these respective sections. However, modern transportation methods have so facilitated the exchange of milling stock between mills located in different parts of the country that infestations of both species may now be found in any section of the country.

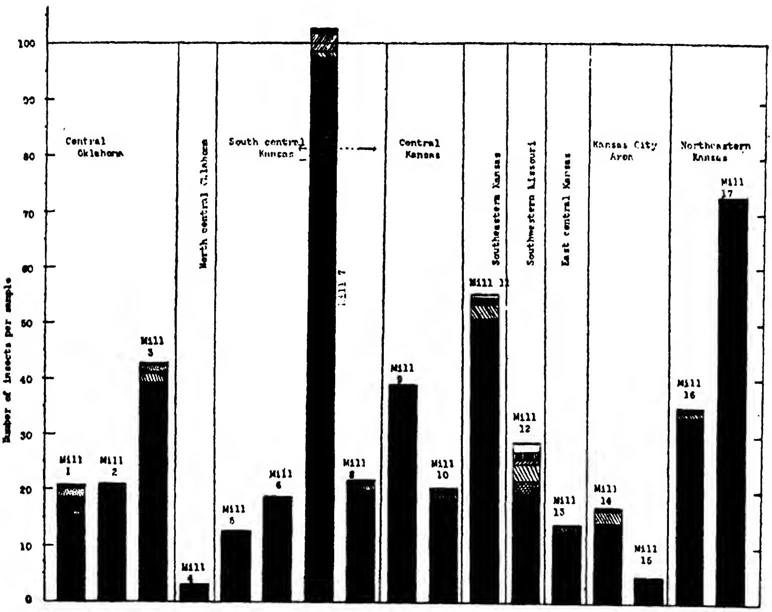

Figure 4. – Average number of insects per 8-oz. sample of all samples taken from the mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri during 1934-1936

-*Tribolium* spp. -*Laemophloeus* spp. -*Tenebroides mauritanicus* L.
-*Rhizopertha dominica* Fab. -*Sitophilus oryzae* L. -*Lathetious oryzae* Waterh.
-All others.

The only genus of importance showing a distinct variation in abundance due to geographical location is **Latheticus.** **L. oryzae** was numerous in two mills in central Oklahoma, in each case being third in total numbers, but was scarce or entirely absent in all the other locations. Incidentally, this insect is seldom found in the eastern and northern parts of the United States.

Gnathocerus cornutus Fab. also shows a distinct geographical limitation, but this species, common in the South and in some parts of the East is almost unknown in the Great Plains. Mill no. 14, in the Kansas City area, was the only one in which this species was found, and only one other record of its occurrence in Kansas is known to the writer.

The saw-toothed grain beetle (**Oryzaephilus surinamensis** L.) was common only in mill no. 12, which is located farther east and in an area that receives more rainfall than any other considered here. This species is seldom present in large numbers in flour mills in Kansas or Oklahoma.

The Lepidoptera **Ephestia, Plodia,** and **Pyralis** were nowhere very numerous, and only in mills nos. 7 and 12, neither of which was fumigated annually, were more than three specimens found.

The abundance of **Palorus** spp. and **Alphitobius** spp. in mill streams appears to be correlated with the location of the elevator boots, since they were taken only in mills in which some of the elevator boots were situated in the basement. These insects, especially the latter, are inhabitants of damp, dark basements and are seldom found elsewhere in the mill.

The records of **Corticaria serrata** Payk. in mill no. 6 and of **Corticaria** sp. and **Anthicus** sp. (4) in mill no. 10 are probably the first records of these species in mill streams in any locality.

The insect population of the mills is closely related to the control measures used. This phase has been thoroughly discussed by Wagner and Cotton (see footnote 3) and will not be gone into further here.

(4). The species in question were determined in the Division of Insect Identification of the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

INSECT POPULATIONS IN THE DIFFERENT MILL STREAMS

Relative total infestations. —The average number of insects per sample for the individual mill streams ranged from 9.0 to 61.3, as shown in table 2. The low-grade-flour elevator boot showed the highest average population, with three of the middlings elevator boots, the fourth, second, and fifth, next in order. The predominant insects were the two species of **Tribolium,** which comprised more than 93 percent of the total number of insects in each of the above-named elevator boots, except the second middlings, where a very heavy infestation of **Laemophloeus** spp. was found in one mill. The high population in the low-grade-flour elevator boot is probably due to the position that the low-grade-flour stream occupies in the milling system and the inability to redress such flour properly, coupled with its greater palatability to insects. The same factors influence the population in the fourth and fifth middlings streams, although to a lesser degree.

The mill streams showing the smallest number of insects per sample were the patent-flour rebolt reel stream, the clear-flour rebolt reel stream, the first-break elevator boot, the wheat elevator boot, and the patent-flour elevator boot, in the order named. The patent and the clear-flour rebolt reel streams contained fewer insects mainly because of the rebolting process, the efficiency of which varied greatly in the different mills under observation. The wheat elevator boot showed the lowest relative infestation by **Tribolium** of any mill stream (39 percent), this being readily explained by the fact that **Tribolium** spp. do not breed freely in sound wheat. The first-break elevator boot had more **Tribolium** per sample than the wheat elevator boot, but the numbers of **Sitophilus oryzae** and **Rhizopertha dominica** were materially reduced by the grinding process, and thus the total population in this stream was low.

Relative abundance of the various species. —The relative abundance of the various species in the different mill streams is shown in figure 5. **Tribolium** spp. are more abundant than all other insects combined in each stream except the wheat stream, and even there they are more numerous than any other one genus. They comprise over 95 percent of all insects in the clear, and patent-

35.

th ings	Fifth middlings	Low-grade flour	Clear flour	Patent flour	Rebolt reel streams: Clear flour	Rebolt reel streams: Patent flour	Purifiers: To sizing roll	Purifiers: To tailing roll	Purifiers: To middling roll	Total number of insects	Total by species	Percentage of total number of insects	Number of samples infested	Percentage of samples infested	Av. numb. insect samp.
97	2,441	1,628	1,029	710	223	166	1,147	1,616	1,704	31,351					
87	479	260	446	309	170	138	376	559	665	8,638					
94	800	111	115	91	48	31	45	90	121	2,000					
0	0	1	0	1	1	0	0	9	3	27	62,786	84.85	1,847	78.0	26.5
63	1,214	1,087	1,082	722	238	204	608	1,385	1,308	20,092					
25	44	23	44	42	6	5	16	18	62	478					
66	11	70	301	36	0	2	8	67	48	5,068					
23	6	121	92	25	1	4	2	13	16	731	5,900	7.95	277	11.7	2.6
0	0	0	0	0	0	0	0	0	0	101					
2	9	0	5	31	0	0	1	0	2	178					
4	0	0	1	0	0	0	0	0	0	38					
56	186	85	194	35	7	1	24	22	29	2,086	2,341	3.16	408	17.2	1.0
0	1	1	1	1	0	0	0	0	0	39					
1	0	0	1	0	0	0	2	0	0	759	1,322	1.78	93	3.9	0.66
0	0	0	1	0	0	0	1	1	0	563					
0	1	0	0	0	0	0	0	0	0	411	679	0.92	98	4.1	0.29
0	0	0	0	0	0	0	0	0	0	268					
16	2	0	23	20	3	5	0	1	2	409					
0	0	0	9	2	0	0	0	0	0	59	566	0.76	91	3.8	0.24
0	0	0	0	0	0	0	0	0	0	5					
0	0	0	0	0	0	0	0	0	0	113					
9	3	0	0	6	0	0	6	1	0	138					
0	2	0	0	0	0	0	0	1	1	15	163	0.22	37	1.6	0.07
0	0	0	0	0	0	0	0	0	0	10					
0	0	0	0	0	0	0	0	0	0	125	130	0.18	9	0.4	0.06
0	0	0	0	0	0	0	0	0	0	5					
0	0	0	0	0	0	0	0	0	0	52	54	0.07	11	0.5	0.02
0	0	0	0	0	0	0	0	0	0	2					
0	1	0	0	0	0	0	0	0	0	22					
0	0	0	0	0	0	0	0	0	0	2	51	0.07	22	0.9	0.02
0	0	0	0	0	0	0	0	0	0	27					
1	0	0	0	0	0	0	0	0	0	34	47	0.06	16	0.7	0.02
0	0	0	0	0	0	0	0	0	0	13					
0	0	0	0	0	0	0	0	0	0	35	35	0.05	8	0.3	0.01
0	0	0	0	1	0	0	0	0	0	2					
0	0	0	0	0	0	0	1	0	0	1	31	0.04	17	0.7	0.01
2	0	0	0	0	0	0	1	0	0	27					
0	0	0	0	0	0	0	0	0	0	1					
0	0	0	0	0	0	0	0	0	0	24	24	0.03	3	0.1	0.01
0	0	0	0	9	0	0	0	0	0	9					
0	0	0	0	5	0	0	0	0	0	5	14	0.02	2	0.1	(a)
0	0	0	0	0	0	0	1	0	0	11	11	0.01	7	0.3	(a)
0	0	0	0	0	0	0	0	0	0	6	5	(a)	5	0.2	(a)
0	0	0	0	0	0	0	0	0	0	4	4	(a)	1	0.04	(a)
0	0	0	0	0	0	0	0	0	0	2	3	(a)	3	0.1	(a)
0	0	0	0	0	0	0	0	0	0	1					
	0	0	0	0	0	0	0	0	0	2	2	(a)	1	0.04	(a)
	0	0	0	0	0	0	0	0	0	2	2	(a)	1	0.04	(a)
	0	0	0	0	0	0	0	0	0	1	1	(a)	1	0.04	(a)
	0	0	0	0	0	0	0	0	0	1	1	(a)	1	0.04	(a)
	0	0	0	0	0	0	0	0	1	1	1	(a)	1	0.04	(a)
	0	0	0	0	0	0	0	0	0	1	1	(a)	1	0.04	(a)
	0	0	0	0	0	0	0	0	0	1	1	(a)	1	0.04	(a)
	4,902	3,557	3,344	2,045	697	556	2,238	3,983	3,958	74,175	74,175	100	1,901	80.31	31.34
	108	58	106	106	64	62	100	97	99	2,367	--	--	--	--	--
	97	52	88	76	31	34	70	75	79	1,901	--	--	--	--	--
	89.8	89.7	83.0	71.7	48.4	54.8	70.0	77.3	79.8	80.3	--	--	--	--	--
	45.4	61.3	31.6	19.3	10.9	9.0	22.4	41.1	40.0	31.3	--	--	--	--	--

Table 2. Insects found in 2,367 eight-ounce samples from 24 different mill streams of 17 flour mills in Kansas, Oklahoma, and Missouri duri

Species of insect	Stage	Condition	Elevator boots: Wheat screenings	Wheat	First break	Second break	Third break	Fourth break	Fifth break	Bran	Shorts	Sizings	First tailings	First middlings	Second middlings
Tribolium spp.	Adults	Alive	1,342	416	525	976	1,211	1,184	1,.18	730	1,422	1,661	1,912	1,641	1,366
		Dead	301	106	307	277	203	384	220	348	470	477	617	362	360
	Pupae	Alive	10	5	16	13	17	56	17	29	51	133	89	106	178
		Dead	0	0	0	0	0	0	0	0	8	0	0	1	0
	Larvae	Alive	634	260	359	620	570	529	560	508	754	1,124	1,149	1,033	1,563
		Dead	4	3	12	1	8	8	0	12	17	30	20	17	45
Laemophloeus spp.	Adults	Alive	20	100	64	216	271	499	602	262	749	35	65	101	1,363
		Dead	5	12	14	22	15	32	3	17	28	4	15	8	164
	Pupae	Alive	0	0	0	1	0	0	0	0	0	0	0	50	50
Tenebroides mauritanicus	Adults	Alive	2	12	13	17	14	22	7	0	0	8	9	12	3
		Dead	8	3	4	1	5	1	2	1	1	2	4	0	1
	Larvae	Alive	67	38	62	134	114	130	126	37	41	91	59	41	193
		Dead	22	2	2	1	0	5	0	0	1	1	0	0	1
Rhizopertha dominica	Adults	Alive	462	261	8	15	2	5	4	2	0	2	2	0	1
		Dead	316	233	3	0	0	0	0	8	0	0	0	0	0
Sitophilus oryzae	Adults	Alive	76	259	45	8	14	1	0	0	1	2	0	4	0
		Dead	120	123	6	2	10	0	0	2	0	1	0	2	0
Latheticus oryzae	Adults	Alive	77	56	53	41	18	7	0	3	1	9	0	26	26
		Dead	2	7	5	1	1	6	0	1	0	0	0	2	0
	Pupae	Alive	0	0	0	0	0	1	0	0	0	3	0	1	0
	Larvae	Alive	9	18	42	35	2	5	0	0	2	0	0	0	0
Palorus spp.	Adults	Alive	8	58	0	14	7	4	0	0	0	8	2	1	7
		Dead	7	2	0	0	1	0	0	0	0	0	0	1	0
	Larvae	Alive	0	0	0	0	10	0	0	0	0	0	0	0	0
Oryzaephilus surinamensis	Adults	Alive	116	6	0	0	0	1	1	0	1	0	0	0	0
		Dead	1	3	0	0	0	0	0	1	0	0	0	0	0
Attagenus piceus	Larvae	Alive	47	4	1	0	0	0	0	0	0	0	0	0	0
		Dead	2	0	0	0	0	0	0	0	0	0	0	0	0
Alphitobius spp.	Adults	Alive	0	3	0	0	2	2	0	8	4	0	1	1	0
		Dead	1	0	0	0	0	0	0	0	0	0	0	1	0
	Larvae	Alive	7	1	1	0	0	6	0	0	6	0	2	1	2
Sitophilus granarius	Adults	Alive	4	27	0	0	0	0	0	0	0	0	0	0	0
		Dead	9	1	1	1	0	0	0	1	0	0	0	0	0
Corrodentia	Adults	Alive	0	0	9	0	10	8	1	7	0	0	0	0	0
Ephestia kuehniella and Plodia interpunctella	Adults	Alive	0	0	0	0	0	1	0	0	0	0	0	0	0
		Dead	0	0	0	0	0	0	0	0	0	0	0	0	0
	Larvae	Alive	0	2	5	5	2	3	0	0	1	4	1	0	0
		Dead	0	0	0	0	0	0	0	0	1	0	0	0	0
Acarina	Adults	Alive	10	0	4	0	0	0	0	0	10	0	0	0	0
Gnathocerus cornutus	Adults	Alive	0	0	0	0	0	0	0	0	0	0	0	0	0
	Larvae	Alive	0	0	0	0	0	0	0	0	0	0	0	0	0
Hymenoptera	Adults	Alive	3	4	1	0	1	0	0	0	1	0	0	0	0
Scenopinus spp.	Larvae	Alive	1	1	0	1	0	0	0	0	1	0	0	0	1
Pyralis farinalis	Larvae	Alive	0	0	0	0	0	0	0	0	0	0	4	0	0
Typhaea stercorea	Adults	Alive	0	0	0	0	0	1	1	0	0	0	0	0	0
		Dead	0	0	0	0	1	0	0	0	0	0	0	0	0
Carpophilus dimidiatus	Adults	Alive	0	0	0	2	0	0	0	0	0	0	0	0	0
Cortlcaria sp.	Adults	Dead	0	0	2	0	0	0	0	0	0	0	0	0	0
Corticaria serrata	Adult	Alive	0	0	0	0	0	0	0	0	0	0	0	1	0
Anthicus sp.	Adult	Alive	0	0	0	0	1	0	0	0	0	0	0	0	0
Unidentified Coleoptera	Larva	Dead	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified Diptera	Adult	Dead	0	0	0	0	0	0	0	0	0	0	0	0	0
Blattidae	Adult	Dead	0	0	0	0	0	1	0	0	0	0	0	0	0
TOTAL			3,703	2,016	1,584	2,304	2,510	2,902	2,662	1,977	3,571	3,595	3,971	3,612	5,324
Number of samples collected			96	105	105	109	108	107	102	89	96	106	110	107	110
Number of samples infested			79	82	73	88	81	89	86	64	80	99	103	94	94
Percentage of samples infested			82.3	78.1	69.5	80.7	75.0	83.2	84.3	71.9	83.3	93.4	93.6	87.8	85.5
Number of insects per sample			38.6	19.2	15.1	21.1	23.2	27.1	26.1	22.2	37.2	33.9	36.1	33.8	48.4

a - Less than 0.01.

flour rebolt reel streams, fourth and fifth middlings, first tailings and sizings elevator boots, and all three of the purifier streams sampled, and make up over 84 percent of the total for all mill streams.

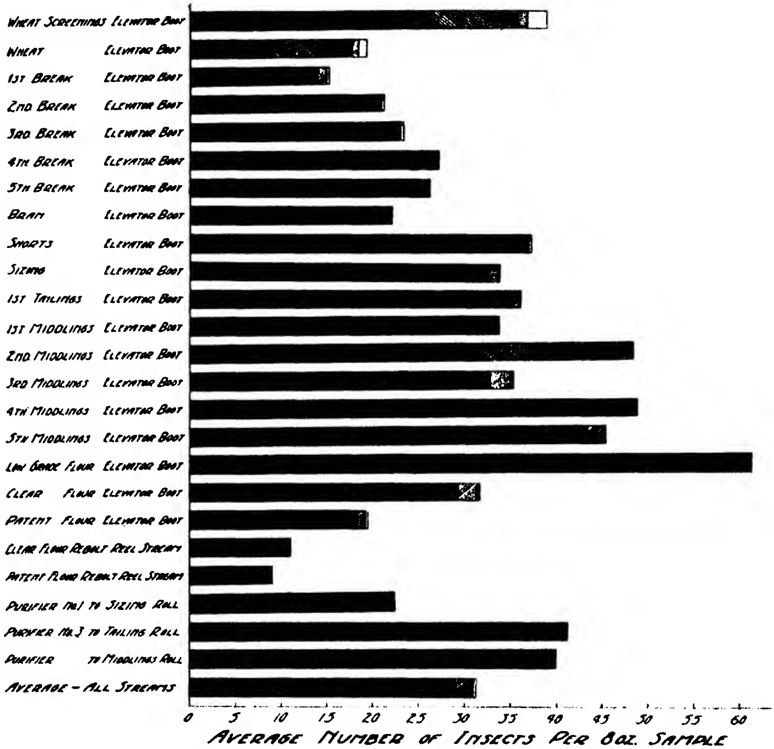

Figure 5 — Average number of insects per 8 ounce sample and proportions of different species found in 2,367 samples from the different mill streams of 17 flour mills in Kansas, Oklahoma and Missouri during 1934 – 1935

Tribolium Spp. Laemophloeus Spp. Tenebroides mauritanicus L. Rhizopertha dominica Fab.
Sitophilus Spp. Latheticus oryzae Waterh. All others

Rhizopertha dominica and **Sitophilus oryzae** are very numerous in wheat and wheat screenings and almost completely absent after the third and fourth break. This, of course, would be expected, since these are grain-feeding, not flour-feeding, insects. The predominance of **S. oryzae** over **S. granarius** is also worthy of note. The total number of all these insects should probably be much higher than indicated here, because only adults were counted, it being impossible to see the larvae and pupae

within the grain.

Laemophloeus spp., although numerous throughout, show apparently inconsistent variations in numbers in certain mill streams, especially in the second middlings and shorts. These inconsistencies can be explained by the fact that a few samples containing unusually large numbers of these insects were taken from elevator boots which contained stock that was slightly out of condition.

Tenebroides mauritanicus is evenly distributed throughout all the mill streams, and does not appear in excessive numbers in any one stream. This species was third in total numbers and second only to **Tribolium** in the percentage of samples infested. Because of its size and its injury to bolting cloth, it is probably exceeded only by **Tribolium** in the quantity of damage done.

Of the other insects present, **Latheticus oryzae, Palorus ratzeburgi** Wissm., **P. subdepressus** Woll., **Alphitobius diaperinus** Panz., **A. piceus** Oliv., and **Ephestia kuehniella** were fairly evenly distributed throughout the different mill streams, although none of them were very abundant in any one stream. **Oryzaephilus surinamensis** and larvae of **Attagenus piceus** Oliv. were moderately abundant in wheat screenings, less so in wheat, and practically absent from other mill streams.

SEASONAL FLUCTUATIONS IN POPULATIONS

Insects inhabiting flour mills are much less influenceed by seasonal and climatic changes than are most insects. This is due to the uniform conditions of temperature and moisture that prevail in the milling streams of flour mills. Modern mills, heated and sometimes even air-conditioned, and frequently operating 24 hours a day over long periods, offer almost ideal conditions for the continuous breeding and development of insect pests.

The seasonal fluctuation in the general insect populations in flour mills as influenced by the various factors that affect it has been discussed by Wagner and Cotton (see reference in footnote 3).

The proportions that each species or group comprises of the total insect population during each month of the year are illustrated in figure 6. The seasonal fluctuation in total insect population is not shown. No collections were made during February, and the November and December collections must be considered as one,

since some of the mills were sampled in November and the rest in December. For this reason the proportions shown for February and for November-December are approximated. The larvae and pupae of **Tribolium** are separated from the adults to illustrate their seasonal distribution. **Tribolium** adults comprised their greatest percentage (74.6) of the total in the November-December collections and their lowest percentage (36.1) in the following month of January, while **Tribolium** larvae and pupae made up their greatest percentage (40.5) in April 1935 followed by April 1934 (37.3), and their lowest percentage (16.9) in November-December. This would

Table 3 -- Seasonal fluctuation in the populations of the insects infesting the milling streams of flour mills, as found in samples from 17 mills in Kansas, Oklahoma, and Missouri.

Species	Stage	Condition	1934 April	May	June	July	August	September	October	November and December	1935 January	March	April	Total
Tribolium spp.	Adults	Alive	1,478	3,262	2,827	2,481	3,945	2,902	5,246	1,722	1,956	3,039	2,493	31,351
		Dead	601	607	997	989	1,590	866	1,325	698	307	520	338	8,838
	Pupae	Alive	259	198	164	53	173	468	241	37	64	178	175	2,000
		Dead	1	5	0	0	2	6	7	6	0	0	0	27
	Larvae	Alive	1,223	1,882	1,175	1,307	2,517	2,385	2,485	472	2,235	2,377	2,034	20,092
		Dead	31	55	88	102	74	61	20	33	8	5	1	478
Laemophloeus spp.	Adults	Alive	263	701	348	111	462	137	264	76	1,172	1,449	85	5,068
		Dead	0	242	159	26	199	79	6	8	2	10	0	731
	Pupae	Alive	0	0	0	0	1	0	0	0	0	100	0	101
Tenebroides mauritanicus L.	Adults	Alive	2	16	7	6	18	41	24	7	16	26	16	178
		Dead	1	2	4	2	10	8	5	5	0	1	0	38
	Larvae	Alive	80	272	128	107	222	191	286	45	310	247	198	2,086
		Dead	0	0	4	0	9	22	3	1	0	0	0	39
Rhizopertha dominica Fab.	Adults	Alive	17	4	22	16	236	133	126	49	136	6	14	759
		Dead	2	3	7	1	248	221	24	0	57	0	0	563
Sitophilus oryzae L.	Adults	Alive	19	52	2	8	18	37	114	26	0	79	56	411
		Dead	76	14	4	1	73	62	22	6	0	2	8	268
Lathetícus oryzae Waterh.	Adults	Alive	0	6	9	16	61	129	137	22	8	10	21	409
		Dead	0	0	0	3	10	14	6	0	3	3	0	39
	Pupae	Alive	0	0	0	0	1	4	0	0	0	0	0	5
	Larvae	Alive	0	0	0	0	35	78	0	0	0	0	0	113
Palorus spp.	Adults	Alive	0	9	14	2	4	14	66	18	0	2	9	138
		Dead	0	0	2	0	1	8	4	0	0	0	0	15
	Larvae	Alive	0	0	0	0	0	0	10	0	0	0	0	10
Oryzaephilus surinamensis L.	Adults	Alive	0	120	0	1	0	2	0	2	0	0	0	125
		Dead	0	0	0	0	2	3	0	0	0	0	0	5
Attagenus piceus Oliv.	Larvae	Alive	0	2	0	0	34	8	2	5	0	0	1	52
		Dead	0	0	0	0	0	1	1	0	0	0	0	2
Alphitobius spp.	Adults	Alive	0	2	0	6	1	0	5	4	0	0	4	22
		Dead	0	0	1	0	0	1	0	0	0	0	0	2
	Larvae	Alive	1	1	0	3	0	3	14	0	0	1	4	27
Sitophilus granarius L.	Adults	Alive	0	27	0	0	0	1	1	0	0	3	2	34
		Dead	1	0	0	0	4	3	4	0	0	0	1	13
Corrodentia	Adults	Alive	0	0	0	0	34	1	0	0	0	0	0	35
Ephestia kuehniella Zell. and Plodia interpunctella Hbn.	Adults	Alive	0	1	0	0	0	0	0	0	0	1	0	2
		Dead	0	1	0	0	0	0	0	0	0	0	0	1
	Larvae	Alive	1	10	1	3	0	0	5	0	6	0	1	27
		Dead	0	1	0	0	0	0	0	0	0	0	0	1
Acarina	Adults	Alive	0	0	0	0	14	10	0	0	0	0	0	24
Gnathocerus cornutus Fab.	Adults	Alive	0	0	0	0	0	0	0	0	0	6	3	9
	Larvae	Alive	0	0	0	0	0	0	0	0	0	5	0	5
Hymenoptera	Adults	Alive	0	0	0	0	4	6	0	0	0	0	0	10
		Dead	0	0	0	0	0	1	0	0	0	0	0	1
Scenopinus sp.	Larvae	Alive	0	0	0	0	0	4	0	1	0	0	0	5
Pyralis farinalis L.	Larvae	Alive	4	0	0	0	0	0	0	0	0	0	0	4
Typhaea stercorea L.	Adults	Alive	0	0	0	0	2	0	0	0	0	0	0	2
		Dead	0	0	0	0	1	0	0	0	0	0	0	1
Carpophilus dimidiatus Fab.	Adults	Alive	0	0	0	0	0	0	0	2	0	0	0	2
Corticaria sp.	Adults	Dead	0	0	0	0	2	0	0	0	0	0	0	2
Corticaria serrata Payk.	Adults	Alive	0	0	0	0	0	1	0	0	0	0	0	1
Anthicus sp.	Adults	Alive	0	0	0	0	1	0	0	0	0	0	0	1
Unidentified Coleoptera	Larvae	Dead	0	0	0	0	0	1	0	0	0	0	0	1
Unidentified Diptera	Adults	Dead	0	0	0	0	0	1	0	0	0	0	0	1
Blattidae	Adults	Dead	0	0	0	0	0	0	0	1	0	0	0	1
Total			4,060	7,495	5,963	5,244	9,998	7,913	10,453	3,246	6,270	8,070	5,463	74,175
Number of samples collected			83	155	130	195	333	306	262	173	224	300	206	2,367
Number of samples infested			77	137	116	145	247	216	234	138	168	238	186	1,901
Percentage of samples infested			92.8	88.4	89.2	74.4	74.2	70.3	89.3	79.8	75.0	79.3	90.3	80.31
Number of insects per sample			48.9	48.4	45.9	26.9	30.0	25.9	39.9	18.8	28.0	26.9	26.5	31.34

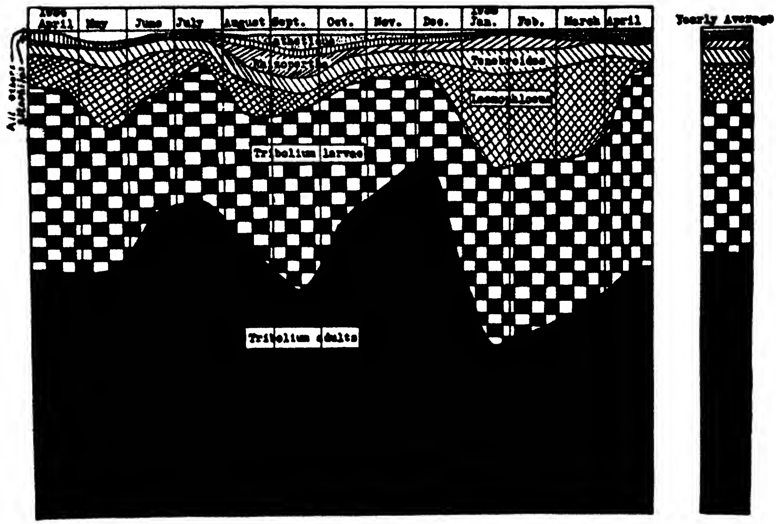

Figure 6.—Seasonal variations in the relative abundance of the different species of insects infesting the milling streams of flour mills, as found in samples from 17 mills in Kansas, Oklahoma, and Missouri during 1934-35.

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be expected, since breeding is at its lowest ebb during the winter months and highest in the spring. **Laemophloeus** spp. were most numerous during January and March (18.7 and 19.3 percent respectively) but, curiously enough, least numerous in April 1935 (1.6 percent). The large number of this species in January and March has been explained above. **Tenebroides mauritanicus** shows in its seasonal abundance the same uniformity that characterizes its geographical distribution and its distribution throughout the different mill streams. This appears to be due to a high reproductive potential coupled with great adaptability but tempered by the presence of some controlling factor, probably the extremely pugnacious nature of the species so that their constant killing of each other prevents more than a few from ever being present in one place at one time.

Latheticus oryzae and, to a lesser extent, **Rhizopertha dominica** show a seasonal distribution, being abundant during the summer and fall but scarce in the winter and spring. The fact that these are normally southern species requiring rather high temperatures may have a bearing on this point.

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WARREN KNAUS
1858-1937.

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Kansas Entomological Society

Vol. 11, No. 1. January, 1938

WARREN KNAUS

Warren Knaus was born in Jay County, near Liber, Indiana, February 24, 1858. He died June 28, 1937, at McPherson, Kansas.

At the age of twelve Doctor Knaus moved West with his parents to a farm near Roper, Wilson County, Kansas, which farm he owned at the time of his death. After graduating from high school in 1876, he taught school for three years and in the fall of 1879 entered the Kansas State Agricultural College. He graduated in 1882, receiving the degree of Bachelor of Science. During the next four years he taught school in Dickinson County and also held a position on the Salina Herald. In 1885 he obtained the Master of Science degree from the Kansas State Agricultural College. On October 1, 1886, there was issued in McPherson County the first democratic paper called "The Democrat", which was edited and published by Doctor Knaus. In 1912 another democratic paper—"The Opinion"—which had been published for several years at McPherson, was purchased by Doctor Knaus and consolidated with the Democrat to form the Democrat-Opinion, which was owned and published by Doctor Knaus up to the time of his death. It was during 1880-1881, when Doctor Knaus was in the class of Entomology taught by Prof. Edwin A. Popenoe, who was an inspiring teacher and scientist, that he became intensely interested in insects and began his hobby. Through the collection of beetles and exchange with other collectors, he not only developed a hobby which asserted itself through his entire life, but also made him an outstanding systematic entomologist and an all-round naturalist.

For nearly fifty years Doctor Knaus spent the greater part of his spare time in making field trips to collect beetles in Kansas, Oklahoma, Colorado, Nebraska, Arizona, Texas, Nevada, New Mexico, California, Utah and Mexico. During all of this time he contributed valuable additions both to the Kansas lists of Coleoptera and

·to the lists of the Southwest. Approximately 40 distinct species of beetles have been named or christened "knausi". On one of his collecting trips to New Mexico he found a beetle which belonged to a new genus and bears the name of "Knausea". During these same years Doctor Knaus corresponded with the most prominent Coleopterists throughout the world, and was recognized by them as an authority on beetles. Many of these men visited him at McPherson, Kansas. For instance, Dr. Walther Horn, whom Doctor Knaus regarded as the greatest living Coleopterist, visited and collected with him in 1902.

The excellent private collection of North American Coleoptera, consisting of nearly 10,000 distinct species and nearly 90,000 specimens, was given by Doctor Knaus to the Kansas State College, his alma mater, in March, 1917. This valuable collection was transferred to the college on July 8, 1937, shortly after his death. His large scientific entomological library also was given to the college at that time. The collection is stored in a fire-proof vault and the scientific library is in the college library.

In 1927 Doctor Knaus was awarded the honorary degree of Doctor of Science from the Kansas State College. McPherson College, McPherson, Kansas, also awarded the honorary degree of Doctor of Science to Doctor Knaus. He was made a member of the honorary society of Phi Kappa Phi of the Kansas State College Chapter. In the spring of 1881, on the advice of Professor Popenoe, he joined the Kansas Academy of Science. He was a faithful member of the Academy for fifty-six years, its president in 1929, and at the time of his death was the oldest living member from the point of view of service. Doctor Knaus was also one of the founders of the Kansas Entomological Society in 1927, and in 1937 was its president. He was the publisher of theJournal of the Kansas Entomological Society.

During the forty-five years that the writer had the pleasure of knowing Doctor Knaus, he found him to be a generous, trustworthy, dependable and loyal friend. His whole life was one of service and he was most happy when serving others. To all who knew him the loss of his fellowship and rich experience is incalculable. In his death, systematic entomology has suffered a real loss and his associates, coworkers and friends in the United

States, Canada, and many other foreign countries, will feel intimately the loss of his fine generosity and stimulating influence.

Geo. A. Dean.

ORTHOPTERA OF AN EASTERN NEBRASKA PRAIRIE

DON B. WHELAN, University of Nebraska.

The following list of Orthoptera is part of an ecological study of the animals of a prairie located about nine miles northwest of Lincoln. It is the same prairie from which two previous studies were made, one on the beetles[1] and one on the mammals[2].

Many of the species were identified by J. A. G. Rehn (R), several by Harold A. Hauke (H) and many by the author (W). The following species were collected:

Mantidae

Oligonicella scudderi bolliana (S-Z) (R). A single specimen was swept from grass on the high prairie, on August 16.

Phasmidae

Diapheromera veliei Walsh (W). Out of several hundred specimens this was the only species present. immature forms were abundant during May and the adults frequently from May 24 to September 3 on both high and low prairie.

Manomera blatchleyi (Caud.) (R). One male was captured on low prairie grass on September 6.

Acrididae

Pseudopomala brachyptera (Sc.) (R). All were captured on low prairie; females July 5 to September 10, and males August 2 to 30. Found on grass and **Solidago rigida.**

Mermiria maculipennis mcclungi Rehn (R). Two specimens were taken on low prairie grass, August 20 and 29.

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1 Whelan, Don B. Coleoptera of an Original Prairie Area in Eastern Nebraska. Jour. Kans. Ent. Soc., ix, pp. 111-115, 1936.

2. ——————. Some Mammals of a Nebraska Prairie. Trans. Kan. Acad. Sci., XXXIX. pp. 365-366, 1936.

Syrbula admirabilis Uhler (W). Found on high prairie grass on September 3.

Eritettix tricarinatus (Thos.) (R). Nymphs were caught from September 6 to April 12, adults from April 23 to July 24 on both high and low prairies. Adults common in May and June.

Eritettix simplex (Sc.) (W). Specimens were taken on May 17 and June 8.

Orphullela speciosa (Sc.) (R.) July 5 to October 10, more common on high prairie in spring and fall.

Dicromorpha viridis (Sc.) (W). One specimen was taken in a low prairie ravine on September 27.

Agenotettix deorum (Sc.) (R). July 10 to October 11, mostly high prairie grass. Numerous in September.

Arphia pseudonietana (Thos.) (R). On August 28 a specimen was taken on the low prairie.

Arphia xanthoptera (Burm.) (R). Nymphs during winter until May, adults March 21 to October 25, mostly on high prairie in summer and low prairie in late fall. Both red and brown forms present.

Arphia simplex Sc. (R). One specimen taken on July 12.

Encoptolophus sordidus (Burm.) (R). August 28 to October 10, mostly in ravines and common in September.

Pardalophora apiculata (Harr.) (R). Adults April 23 to October 25, and nymphs August 30 until spring, mostly on high prairie.

Pardalophora haldemanii (Sc.) (H). June 1 to September 23. It over-winters as a nymph.

Dissosteira carolina (L.) (R). Two specimens taken, on August 15 and 20, on low prairie not far from a road.

Brachystola magna (Gir.) (R). Nymphs taken July 12 and August 20, adults August 2 to September 7, all on low prairie.

Schistocerca americana Harr. (H). One specimen, July 30 on high prairie.

Schistocerca alutacea Harr. (H). Adults August 2 to October 12, mostly on low prairie and on **Solidago rigida.** Three nymphs August 2, 10 and 16.

Schistocerca lineata Sc. (H). Taken on August 20 and October 20.

Hypochlora alba (Dodge) (R). Adults on high prairie August 16 and low prairie August 2 to September 10, later on **Solidago rigida.** Nymphs August 28.

Campylacantha olivacea olivacea (Sc.) (R). Taken September 8 and again October 10.

Hesperotettix brevipennis pratensis (Sc.) (R). July 5 to October 10, mostly on low prairie. Common during July and August.

Hesperotettix speciosa (Sc.) (W). Two specimens caught on August 29.

Melanoplus scudderi latus Morse (R). From September 14 to October 25, a mating pair captured on the former date.

Melanoplus differentialis (Thos.) (W). Nymphs until August 20, adults August 2 to September 27. More numerous on low prairie.

Melanoplus bivittatus (Say) (W). Nymphs May 17 to August 30, adults July 5 to September 3. Common on low prairie.

Melanoplus dawsoni (Sc.) (R). A few brachypterous forms taken between August 3 and October 25.

Melanoplus confusus Sc. (R). May 27 to September 20, mostly on low prairie. Common in June and July.

Melanoplus femur-rubrum femur-rubrum (DeG.) (R.) Adults July 26 to October 10, most common in July and August on both high and low prairie.

Melanoplus mexicanus mexicanus Saus. (R). From July 5 to October 25, very common during August and September. Mostly on high prairie.

Melanoplus keeleri luridus (Dodge) (R). Adults July 30 to October 25, common in August and September. Nymphs mostly taken from spring until August.

Phoetaliotes nebrascensis (Thos.) (R). Nymphs from July 5 to August 8, adults from August 18 to October 25, mostly on grass, one on weeds and one on **Solidago rigida.**

Tettigoniidae

Phaneroptera texensis (S & P) (R). Nymphs were taken from June until August 9, adults July 26 to October 10 in grass and on **Solidago rigida.** Quite common during August and September.

Phaneroptera furcata furcata (Brun.) (R). Nymphs until August 18 and adults from August 20 until October

9, on low prairie.

Amblycorypha parvipennis brachyptera Ball (R). A female was taken on August 8 and a male on July 10.

Microcentrum rhombifolium (Sauss.) (R). Collected on September 5 and October 7.

Neoconocephalus ensiger (Harr.) (R). Nymphs July 12 to August 2. Adult males July 18 to September 30 and females August 16 to September 20.

Orchelimum vulgare Harr. (R). Very common on low prairie and in the ravines, especially on **Solidago rigida** and **Solidago glaberrima.** Adults from July 26 to September 18.

Conocephalus fasciatus fasciatus (DeG.) (H). One specimen was taken on August 20.

Conocephalus brevipennis (Sc.) (R). A male was taken on August 28 and a female on September 6.

Conocephalus nemoralis (Sc.) (R). One nymph and two adult specimens, both females, taken in a prairie ravine on August 30.

Conocephalus strictus (Sc.) (R). Adults August 8 until October 25 on both high and low prairies, nymphs on high prairie August 16 until early October.

Conocephalus nigropleurum (Brun.) (R). Two specimens were taken in a ravine, one on August 23 and the other August 30.

Conocephalus saltans (Sc.) (R). Macropterous forms August 2 to August 28. Brachypterous forms August 16 to October 10. Both found on high and low prairies.

Phrixocnemis sp. (W). Two nymphs, caught on April 23, under stones on low prairie.

Gryllidae

Gryllus assimilis (Fab.) (H). Caught on three dates, July 8, 10 and 16.

Nemobius fasciatus fasciatus (DeG.) (R). One nymph August 18 and one adult on September 20, in low prairie.

Oecanthus nigricornis quadripunctatus Beut. (R). Swept from grass, weeds and from **Solidago glaberrima,** July 12 to October 3, on low prairie, mostly in August.

Oecanthus niveus (DeG.) (R). Only taken from weeds on high prairie on August 28.

NOTES ON OVIPOSITION AND SEX RATIO IN HYPOSOTER PILOSULUS PROV. (HYM.: ICHNEUMONIDAE)

RALPH B. SWAIN*,
WILLIAM GREEN, ROLAND PORTMAN

In mid-September, 1935, an experiment was undertaken at Ft. Collins, Colorado to determine the sex ratio in **Hyposoter pilosulus** Prov., a primary, ichneumonid parasite of the fall webworm, **Hyphantria cunea** Drury. Parasite material was on hand in abundance from rearings made during the summer by the senior author. The fact that he had reared only male wasps from the eggs of unmated females prompted the further investigation.

Normally there are two generations of **Hyposoter** upon the fall webworm at Fort Collins. The wasps from which the first stingings were obtained in this experiment were late-issuing individuals of the regular second generation, or individuals reared in the insectary from early-issuing second generation wasps.

The female wasps were kept in 2 and ½ by 10 centimeter glass vials with cotton stoppers. They were given sugar water for food. Into these vials males were introduced for mating and webworm larvae for oviposition.

Behaviour During Oviposition

Hyposoter females are attracted to webworm larvae in all stadia from the second to the last. (**H. cunea** larvae pass through eight stadia at Ft. Collins, Colo.) The wasp is usually immediately aware of the presence of a webworm larva in its vial. It vibrates its antennae more and more rapidly, then runs toward the victim. The larva may sense the approach of the wasp. At any rate, by the time the wasp has brushed the larva with its antennae, the latter is vigorously trying to escape, thus presenting the posterior part of the body to its pursuer. This is probably why most eggs are laid in the hinder parts of the larvae. Not infrequently, however, wasps oviposited just back of the head of the larva. During the act of oviposition the wasp bends the abdomen underneath the thorax and stabs forward with the ovipositor. If the thrust is successful and the skin of the webworm is pierced, the wasp usually loses its hold on the wall of

* Formerly of the Dept. of Ent. and Zool., Colorado State College, Ft. Collins, Colo.

the vial and is dragged along for a second by the retreating larva. It then finds a foothold and releases the ovipositor. In the field, the wasp has been seen beating its way through the webbing of the **Hyphantria** nests in pursuit of larvae. A wasp may stab its victim repeatedly, often three to five times, apparently ovipositing, before the larva can be removed from the vial.

Progeny of Virgin Females

The sixty- eight wasps reared from the eggs of twelve unmated females in this experiment as well as forty-nine reared from three unmated females earlier in the season by the senior author were all male.

Mating

Eight matings occurred under observation. The male seizes the female by the abdomen with the first pair of legs and bends the tip of its own abdomen down and forward to meet that of the female. The time required for copulation varied from three and one half to six minutes, an average of about five minutes.

Progeny of Mated Females

Ninety-two adults were reared from the eggs of seven mated females, the distribution of the sexes being as follows:—

Mother	Progeny	
Cage No.	**Male**	**Female**
I.	9	8
II.	1	10
III.	1	11
IV.	2	4
V.	1	1
VI.	14	4
VII.	16	10
Total	44	48

The ratio of males to females in the progeny of mated females is approximately one to one.

General Observations

According to Tothill* the parasite has three larval stadia. Dissections of parasitized webworms were not made in this study, but the following information was gathered concerning the length of the larval and pupal periods from records on one hundred and fifty-nine wasps reared in a greenhouse with a minimum temperature of 60 degrees Centigrade:—the average length of time required for growth from egg to adult was forty-three days; the average time from oviposition to formation of cocoon was thirty-two days; the average time from formation of cocoon to issuance, approximately the pupal period, was eleven days.

The longest-living wasp issued October 15 and died November 2, a space of eighteen days. It oviposited in thirty webworm larvae. Another female, living fourteen days, oviposited in ninety-six larvae. This wasp deposited the following number of eggs on each of nine successive days: 4, 8, 25, 17, 12, 1, 17, 9, 3.

In general, wasps would oviposit in webworm larvae within a very short time after issuance and would be just as active at night under artificial light as in the daylight. Quite often a wasp would oviposit in larvae given it at the rate of one or more a minute for as many as twenty minutes without seeming to tire. One wasp stung forty-seven larvae within two hours and five minutes.

Last stadium webworms stung by wasps invariably pupated. The parasite larva could usually be found within the pupa, often in the third stadium, apparently dead of phagocytosis. No wasp was ever reared from a webworm pupa.

Conclusions

Hyposoter pilosulus Prov., an ichneumonid parasite of the fall webworm, is easily reared under laboratory conditions. Webworms in all stadia from the second to last are attractive to the parasite, but parasites probably never issue from larvae parasitized in the last stadium. Eggs from virgin wasps produce only males. Eggs from mated females produce both males and females in the ratio of approximately one to one. A female wasp may live considerably more than two weeks in the laboratory and may lay as many as forty-seven eggs in a day.

* Tothill, J. D. Dom. Can. Dept. Agr. Bull. n. s. 3, 1922. The natural control of the fall webworm in Canada, etc.

NOTES ON AN INTERESTING FOOD HABIT OF FALSE WIREWORM ADULTS

H. H. WALKDEN, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, and H. R. BRYSON, Kansas Agricultural Experiment Station*.

The literature pertaining to the false wireworms contains several brief notes on the food habits of the adults, but the writers were unable to find mention of the interesting food habit described in this paper. Therefore, it appears worthwhile to place these observations on record, together with a brief summary of the references on the subject known to the writers.

Hyslop (4) observed the adults feeding on the seed of corn and wheat; on leaves of corn, of **Polygonum littorale,** and of other weeds; and on decaying vegetable matter. Webster (9) states that **Eleodes sulcipennis** Mann. was reported by farmers to feed upon the larvae of the alfalfa weevil in Utah, and that **Eleodes suturalis** Say was reported by E. O. G. Kelly to devour chinch bugs near Wellington, Kans., but apparently preferred the partially decayed leaves of corn under which the chinch bugs were hiding. Baerg (1) reports that the adult beetles of **Eleodes tricostata** Say feed on the foliage of many of the common weeds and grasses. McColloch (6) states that the adults of **Eleodes opaca** Say feed on a wide range of food plants, and were observed in the field feeding on evening primrose, Russian thistle, alfalfa, and damp wheat in the stack or shock. One beetle was found feeding on a nymph of **Melanoplus differentialis** Thomas. McColloch also states (5) that **Eleodes quadricollis** Esch. was recorded by Riley as injuring grape foliage in California, and that **Eleodes omissa borealis** Blaisd. was noted by Essig feeding on leaves of apricot, orange, plum, and watermelon, and that the adults of **Eleodes tricostata** Say have been found feeding in the field on Solidago, **Euphorbia marginata,** prairie clover, and evening primrose. Wakeland (8) observes that the adults of **Eleodes hispilabris** Say have a wide range of foods, and that a complete list would include nearly everything of an organic nature found in their habitat. Yothers (10) records the adults of **Sphaeriontis muricata** Leconte as injurious to the buds, blossoms, and young leaves of fruit trees in Washington. Beamer (2) reports the collection

* Contribution No. 447 from the Department of Entomology.

in the Medora Sand Hills of several adult **Eleodes hispilabris nupta** Lec. at mouse traps baited with dry oatmeal.

On September 21, 1936, the senior author observed large numbers of false wireworm adults congregated on the mounds of the mound-building prairie ant, **Pogonomyrmex occidentalis** Cresson, in a wheat-stubble field near Meade, Kans. There were many beetle-infested mounds in this field. Several hundred beetles were observed on some of the large anthills, the concentration being greater on the larger mounds.

On closer examination it was found that the beetles were devouring seeds which the ants had dropped here and there in the sand composing the mound. No observations were made regarding the kinds of seeds being gathered by the ants, or the particular types of seeds taken by the beetles. Headlee and Dean (**3**) report that many different kinds of seeds are gathered and stored in the galleries, the kind of seeds being governed by the species of plants surrounding the mound. Occasional beetles were noted burrowing into the gallery entrances of the ant hills, but it was not determined whether they were able to penetrate deeply enough to reach the stored seed.

In a number of instances an ant returning to the nest with a seed was observed to be set upon by several beetles and robbed of its food. Eight or ten of the beetles would beset the ant, piling up in a struggling mass, those on the outside attempting to penetrate to the seed while those on the bottom were forced outward. The contest continued until some fortunate individual made off with the seed, whereupon the contestants would disperse and resume their search for food. Viewed from a distance of a few feet the moving mass of beetles presented the appearance of a slowly revolving ball. With the onset of the beetles, the ant promptly dropped the seed and attempted defense by biting at the legs of her attackers. However, the colony in general was apparently undisturbed by the presence of so many intruders.

The above observations were made about 5 P. M. on a warm sunny day. On the following day (September 22) the field was visited again at about the same hour. Very few false wireworm adults could be found, owing no doubt to the lower temperature and clouds obscuring the sun.

On October 8, 1936, near Stockton, Kans., the authors observed the same phenomenon of false wireworm adults congregated on ant hills and stealing seeds from the ants. Similar observations were made at intervals along the road between Stockton and Ellis, Kans., on the same date.

Parks (7) states that the adults of **Eleodes tricostata** Say have a very peculiar habit of sunning themselves on anthills during the warm days of winter, and that there must be some vital connection between this beetle and the agricultural ant, as adult **Eleodes** are more abundant near the anthills than elsewhere. He does not mention the peculiar predatory habit herein described.

Evidently this habit of robbing ants of their food is possessed by several species of the false wireworms, since collections made on anthills at Meade and Stockton, Kans., and roadside collections between Stockton and Ellis, showed the following species to be present: **Eleodes obsoleta** Say, **E. opaca** Say, **E. suturalis** Say, **E. tricostata** Say, and **Eusattus difficilis** Leconte. The identifications were made by the junior author. **Eleodes obsoleta** was the predominant species at Meade on September 21, while **E. opaca** was taken in greatest abundance on October 8, in the vicinity of Stockton.

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THREE MACROSIPHINA APHIDS[1]

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The following report deals with three apparently undescribed aphid species belonging to the subtribe Macrosiphina. One constitutes a third member of the **Macrosiphum albifrons** group, the other two being placed in genus **Amphorophora.**

Amphorophora Goldamaryae n. sp.

Apterous vivipara.—Size 2.35 to 2.5 mm. long; 0.91 to 1.25 across abdomen; 0.49 wide through eyes; antennae pale to near apex of IV, mostly dusky beyond, 3.41 to 3.64 mm. long; antennal III, 0.84 to 0.884 mm. long with 3 to 4 sensoria; IV, 0.61 to 0.632; V, 0.6 to 0.65; VI, 0.142 to 0.173+0.99 to 1.1; rostrum reaching third coxae; rostral IV plus V, 0.13 long, apex slenderly obtuse; hind tibiae 2.1; hind tarsi 0.11; cornicles pale, imbricated, with 4 to 5 rows of reticulations at apex; cauda pale, 0.34 total length, 0.26 mm. long on mid-line.

Alate vivipara.—Size 2.45 mm. long; width through eyes, 0.5; antennae 4.3 long, dusky beyond first sensorium, becoming darker beyond; antennal III, 0.96 mm. with 18 to 20 sensoria; IV, 0.77; V, 0.79; VI, 0.2+1.26 mm.; hind tibiae 2.5; hind tarsi 0.14; cornicles pale, 0.76; cauda pale, 0.35 mm. long with three lateral hairs

Collections.—Taken upon goldenrod, **Solidago canadensis,** in Brigham Canyon and Logan Canyon, Utah, June 17, 1925 (G. F. Knowlton and Mary W. Knowlton).

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1 Contribution from the Department of Entomology, Utah Agricultural Experiment Station.

Taxonomy.—Apterous **Amphorophora goldamaryae** run to **Amphorophora pallida** Mason in Mason's key (Proc. U. S. Nat. Mus., 67:6, 1925) from which they differ in antennal tubercles not unusually long, less dilation of longer cornicles, cauda not constricted at base, and longer antennal segments, especially III. It more nearly resembles **A. spiraecola** Patch, from which it differs in having cornicles shorter than antennal III, antennals IV and V distinctly shorter than III, and shorter base of VI*.

Types—In the collection of the writer and in the U. S. National Museum.

Amphorophora janesi n. sp.

Alate vivipara.—Abdomen apple green; size 1.9 mm. long, 0.8 wide across abdomen, and 0.38 across eyes; antennae 2.25 plus mm. long, black; antennal III, 0.51 with 12 sensoria; IV, 0.43; V, 0.41; VI, 0.126 plus 0.55 plus mm.; rostrum reaching second coxae; rostral IV plus V, 0.12 mm. long, obtuse at apex; wing venation normal, but with faint shading along margin of cubitus, darker bordering along anal, which fans out as it approaches anal margin of wing and dusky, broken areas on membrane near both sides of proximal half of anal; hind tibiae 1.29; hind tarsi 0.12; cornicles 0.63 mm., black, lightly imbricated, distal row or two approaching a faintly reticulated condition; cauda pale, 0.22 mm. total length, with 2 lateral hairs.

Apterous vivipara.—Color apple green; size 1.6 to 1.7 mm. long and 0.38 across eyes; antennae black beyond base of III, 2.21 to 2.27 long; antennal III, 0.49 to 0.57 mm. long, without sensoria; IV, 0.34 to 0.38; V, 0.34; VI, 0.11 plus 0.7 to 0.12 plus 0.67 mm.; rostrum reaching third coxae; rostral IV plus V, 0.11 to 0.126; hind tibiae 1.2 to 1.34; hind tarsi 0.11 to 0.13; cornicles black, 0.62 to 0.73, last row or two in stage bordering between reticulations and imbrications; cauda 0.2 midline, 0.25 mm. total length.

Collections.—In Red Canyon, above Cedar City, Utah, May 2, 1934 (G. F. Knowlton). Host?

Taxonomy.—**Amphorophora janesi** keys to **Amphorophora nervata** (Gillette) in Mason's key (Proc U. S. Nat. Mus., 67: 5-7), from which it differs in having

* The writer is indebted to Dr. P. W. Mason for his opinion concerning this species.

noticeably darker cornicles and antennae, and dark tibiae in both aptera and alate. It differs from **A. morrisoni** (Swain) in having darker and less swollen cornicles with much less apparent reticulations and fewer lateral hairs on cauda. Named in honour of the author's former associate, M. J. Janes.

Types.—In the collection of the writer and in the U. S. National Museum.

Macrosiphum thermopsaphis n. sp.

Apterous vivipara.—Color light green with a dorsal covering of grayish pulverulence; size 3.9 to 4.51 mm. long to base of cauda; antennae 5.03 to 5.59 mm. long, pale to dusky on proximal end, gradually becoming darker toward apex; antennal III, 1.16 to 1.31 mm. long and typically with 5 to 17 sensoria usually confined to basal half of segment; IV, 1.02 to 1.15; V, 0.86 to 1.04; VI, 0.19 to 0.24+1.65 mm.; rostrum reaching second coxae, apex slenderly obtuse; rostral IV plus V, 0.158 mm. long; hind tibiae 3.4 to 4.4; hind tarsi 0.22 to 0.24; cornicles pale, dusky at tip, 0.95 to 1.27 mm. long; cauda pale, 0.65 to 0.82 mm. long, and 0.56 to 0.68 on mid-line.

Alatea vivipara.—Color green, pruinose; size 2.95 to 3.25 mm. long; 0.66 through eyes; antennae 5.27 to 6.2 mm. long, dusky, becoming darker beyond middle of IV; antennal III, 1.2 to 1.27 mm. long with 28 to 39 sensoria; IV, 1.24 to 1.26; V, 1.11 to 1.14; VI, 0.24+1.86; hind tibiae 2.73 to 3.84; hind tarsi 0.22 to 0.24; cornicles pale, dusky to blackish at tip, 0.82 to 0.92; cauda pale, 0.58 mm. total length.

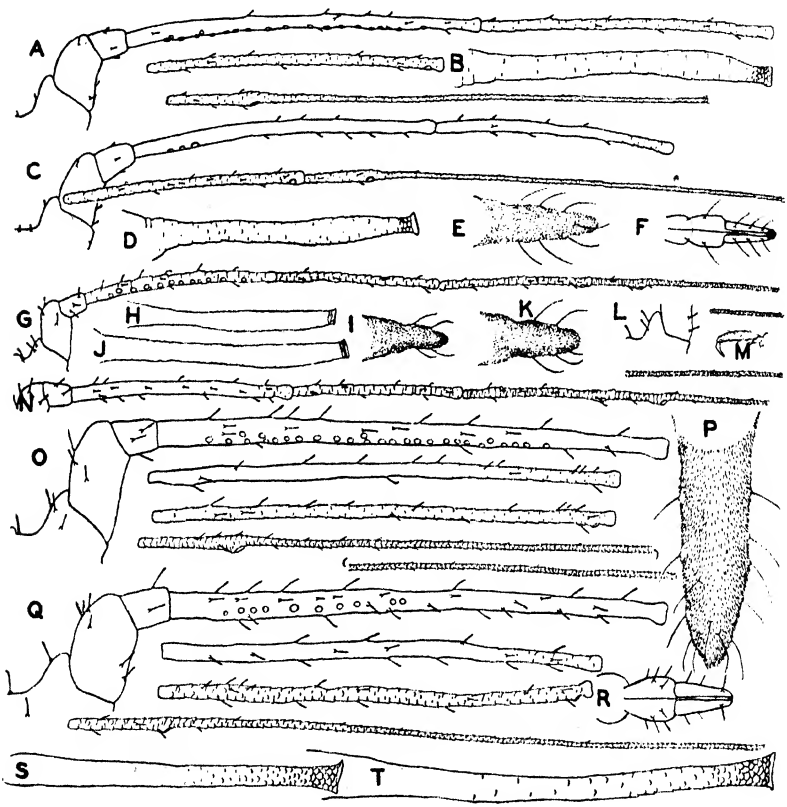
Collections.—Pingree Park, Colorado, August 19, 1935, on **Thermopsis pinctorium** (G. F. Knowlton—M. A. Palmer), and August 20-22, 1935 (Knowlton). Rather abundant.

Taxonomy.—**Macrosiphum thermopsaphis** differs from **M. zionesis** Knlt. in having pale cornicles, shorter hind tarsi, and more secondary sensoria; it differs from **M. albifrons** Essig in possessing fewer sensoria on antennal III of aptera, and in antennal IV being almost equal to or longer than III, rather than 0.14 to 0.3 mm. shorter.

Types.—Type in the U. S. National Museum. Paratypes in the collections of the Utah and Colorado Agricultural Experiment Stations, and in the collection of the writer.

Legend

Amphorophora goldamaryae n. sp. Alate, A-B; aptera, C-F. **A. janesi** n. sp. Alate, G-I; aptera, J-N. **Maccrosiphum thermopsaphis** n. sp. Alate, O. S; aptera, P-R, T.



RECORDS OF HISTERIDAE FROM IOWA

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Wickham (Bull. Lab. Nat. Hist., State Univ. Iowa, VI, 1909, pp. 19-20) lists 40 species of Histeridae from Iowa, which, according to the classification given in Leng's **Catalogue,** may be reduced to 38 species and two varieties. The present paper adds 14 species and four varieties to this list.* In addition notes are given on another species, a new species of **Dendrophilus** is described, and a key to the North American and European species of the genus is given. This contribution has been made possible through the kindness of Prof. H. E. Jaques of Iowa Wesleyan College in allowing me to study some of the Iowa Histeridae in his collection.

List of Species

Hister interruptus Beauv. Des Moines Co., Jackson Co., Louisa Co., Page Co.

Hister jaquesi Hatch. In addition to the type from Mt. Pleasant, I have now seen two additional specimens from the type locality and one specimen from Jackson Co.

Hister marginicollis LeC. Adair Co., Kossuth Co., Linn Co., Louisa Co., Page Co., Scott Co. (Davenport), Taylor Co., Union Co.

Hister (Atholus) americanus var. **perplexus** LeC. This form, recorded from the state by Wickham, is represented in the present collection by specimens from a series of counties (Adair Co., Appanoose Co., Des Moines Co., Dickinson Co., Henry Co. (Mt. Pleasant), Ida Co., Marion Co., Union Co.). The fifth dorsal stria may be arcuate at the base and joining the sutural, or the sutural stria may be abbreviated at the base with the fifth dorsal entire (the usual condition in this series), or both fifth dorsal and sutural may be abbreviated at the base.

Hister (Atholus) nubilus LeC. Clarke Co.

Platysoma aurelianum Horn. Dickinson Co., Lucas Co., Scott Co., (Davenport).

Platysoma (Cylistosoma) coarctatum LeC. Washington Co.

* In addition Casey (Mem. Col., VI, 1916, pp. 211, 253) has described **Hister (Spilodiscus) iowensis** and **Acritus (Aeletes) politus** subsp. **robustulus** from the state, making a total of 53 species and seven varieties of Histeridae now recorded from Iowa.

Phelister vernus Say. Des Moines Co.

Xestipyge geminatum LeC. Scott Co.

Dendrophilus sexstriatus sp. nov. Henry Co. (Mt. Pleasant), Monroe Co.

Saprinus posthumus Mars. Bremer Co., Mardin Co., Henry Co. (Mt. Pleasant), Jackson Co., Jefferson Co.

Saprinus lugens Er. Cerro Gordo Co., Dickinson Co., Jefferson Co., Monroe Co., Polk Co., Scott Co. (Davenport).—ab. **oregonensoides** Hatch. Cerro Gordo Co., Dickinson Co.— ab. **distinguendoides** Hatch. Monroe Co., Scott Co. (Davenport).— ab. **sejunctoides** Hatch, Can. Ent., LXI, 1929, p. 78 (Dickinson Co.).

Saprinus lecontei Csy. Des Moines Co., Dickinson Co., Henry Co. (Mt. Pleasant), Jefferson Co., Louisa Co., Mahaska Co., Page Co., Van Buren Co.

Saprinus oregonensis LeC. ab. **distinguendus** Mars. Dickinson Co.

Saprinus assimilis Payk. ab. **semisulcatus** Hatch. Des. Moines Co., Dickinson Co., Henry Co. (Mt. Pleasant), Jefferson Co., Mahaska Co., Van Buren Co., Wright Co. This abberation was established for those specimens in which the marginal groove of the pygidium is interrupted at the apex. About half the series of about fifty Iowa specimens of this species at hand exhibit this character, which varies all the way from a very narrow to a very wide interruption of the groove.

Saprinus (Hypocaccus) jaquesi Hatch., Can. Ent., LXI, 1929, p. 83 (Dickinson Co.).

Dendrophilus sexstriatus sp. nov.

Length 3 mm.; black; head and pronotum densely punctate, alutaceous; the punctures of the pronotum just visibly less dense at the center of the disc and in general less dense than on head; pronotum with apex and margins margined; elytra alutaceous throughout, somewhat more strongly so towards apex, densely punctate at apical half and on the sides to the first dorsal stria, the extreme apex somewhat strigose, the intervals between the first and second and the second and third dorsal striae more finely and sparsely punctate, the scutellar area mesad of the third dorsal stria very finely and sparsely punctate, shining; elytra with outer subhumeral entire, deep-

ly impressed, with the inner subhumeral obsolete, with five dorsals and a sutural present and punctate but becoming lost in the apical punctate area at about the apical two-fifths, the sutural and fifth dorsal somewhat more feebly impressed than the others; epipleurae densely punctate, broadly margined along inner side; propygidium, pygidium, legs, and venter nearly as in **punctatus.**

Type and paratype: Monroe Co., Iowa. Apr. 21, 1930. H. Knight (in collection of author). Paratype: Mt. Pleasant, Ia., Feb. 26, 1931. Hagedun (in collection H. E. Jaques).

This species may be distinguished from the other North American and European species of the genus by means of the following key. Of the species cited in the key, **californicus** is known to me from description only.

Key to North American and European Species of **Dendrophilus** Leach

A. Dorsal surface and elytral striae punctate; color black

B. Elytral surface nearly equally shining throughout

C. Elytra nearly uniformly punctate, only dorsal striae one to four present, the fifth dorsal and the sutural nearly completely obsolete; length 3 mm.; Europe, Caucasus; Quebec (**Chagnon**) and District of Columbia (**Ulke**) to Manitoba (**Leng**) and Kansas (**Hatch**); (**punctulatus** Say) .... **punctatus** Herbst

CC. Elytra coarsely and densely punctate apically and laterally, finely sparsely punctate over an extensive sutural area; dorsal striae one to five and a sutural stria present, the fifth dorsal and the sutural somewhat more feebly impressed than the others; length 3 mm.; Iowa. .... **sexstriatus** sp. nov.

BB. Elytra dull at apex; dorsal striae one to four impressed, the fifth dorsal and the sutural stria short and composed of punctures only; length 3 mm.; California. .... **californicus** Horn

AA. Dorsal surface opaque, impunctate; elytra with four or five finely impressed impunctate dorsal striae; **gen-**

eral color dull rufous; length 2.5-3 mm.; Europe
.... **pygmaeus** L.

The separation of **punctulatus** Say and **punctatus** Herbst has rested largely upon the results of the examination of a single American specimen by Marseul in 1857 (Ann. Soc. Ent. Fr., (3) V, 1857, p. 436) in which that author reports that **punctulatus** "is very similar to **D. punctatus,** but its size is a little greater (3.5 as opposed to 3 mm. in length); its elytra proportionately more elongate; its punctation more dense, more fine; its front less convex; the suture of its elytra elevated and its striae differing in number (4 in **punctulatus,** 5 in **punctatus)** and in relative length."* The figures of the two species given by Marseul (l. c. (3) III, 1855, pl. IX, fig. XXX, 1 and (3) V, 1857, pl. XI, fig. XXX, 1) are indistinguishable, except that a short subhumeral stria is figured for **punctulatus.** In my opinion all the differences cited are within the limits of individual variation. Especially are there variable but very feeble evidences of a subhumeral and fifth dorsal and even a sutural stria in both American and European specimens.

* Translation by author.

THE DIPTEROUS FAMILIES NEMESTRINIDAE, CYRTIDAE, AND SCENOPINIDAE IN COLORADO

MAURICE T. JAMES, Colorado State College.

Only one species of Nemestrinidae, two of Cyrtidae, and one of Scenopinidae have been recorded in literature from Colorado, so far as I can determine. The following remarks will add to our knowledge of these rather uncommon families.

NEMESTRINIDAE

Neorhynchocephalus sackeni Williston

This species is not as uncommon in Colorado as has formerly been supposed. It occurs regularly in mixed grassland (**Stipa comata, Agropyron smithii**) near Boulder in June and July; I also have Colorado records as follows: Masonville, May 30, 1936 (M. T. James); Spring Canyon, Ft. Collins, June 8, 1936 (James); Horsetooth Gulch, near Ft. Collins, June 15, 1895 (Gillette and Baker); Ft. Collins, June 12, 1900; Crystal Springs Country Club, Flagler, July 25, 1933 (H. G. Rodeck, M. T. James).

CYRTIDAE

Acrocera obsoleta Van der Wulp.

Cole recorded this species from Denver.

Acrocera convexa Cole.

4 males, 4 females, Ft. Collins, Aug. 12, 1937 (M. T. James); 2 males, 1 female, Ft. Collins, Aug. 13, 1937 (Helen B. James)

These specimens were taken in a sedge border of a cat-tail marsh about 5 miles southwest of Ft. Collins. The milkweed, **Asclepias incarnata** L., formed a conspicuous part of the flora of the region.

Ogcodes albicinctus Cole.

Cole has recorded this species from Ft. Collins; I have a series from Boulder, June 9, 1928 (E. C. Nelson), and Boulder, Feb. 28, 1933 (C. H. Hicks). The latter

specimens had been used by a wasp, species unknown, to stock its nest.

Opsebius diligens Osten Sacken

Female, Boulder, June 25, 1931 (T. D. A. Cockerell).

SCENOPINIDAE

Pseudatrichia helenae, new species.

Related to **P. griseola** Coq., but smaller in size, the abdomen is definitely marked with black, the femora are black, and the knobs of the halteres are white. The abdomen is varied black and yellow, not black and white, as in **albocincta** Cole, and the arrangement of the pilose areas of the thorax is much different.

Male. Length, 2-2.5 mm. Frontal triangle, facial orbits, cheeks, and the narrow occipital orbits yellow; the frontal triangle somewhat clouded with pollen; proboscis dull yellow; antennae black. Thorax black in ground color, but yellow on the humeri, a spot behind each humerus and contiguous with it, the post alar calli, the sides of the scutellum, a large part of the propleura, and an extensive, somewhat interrupted, area below each wing and taking in parts of the pteropleura, sternopleura, hypopleura, and metapleura; the black parts are clouded by a grayish pollen which becomes yellowish-gray on the dorsum, where there is evidence of three indistinct brown stripes. Abdomen yellow; the first segment, however, except at the narrow base and apex, black; the second, third, fourth, and fifth segments each with a transverse black marking basally; the pile of the thorax and abdomen as well yellow, rather sparse. Genitalia rather large, brown at base, yellow at apex. Femora black, tibiae yellow, tarsi brown. Halteres brown, the knobs yellow.

Holotype, male, and paratype, male, Roggen, Colo., May 29, 1937 (Helen B. James).

Scenopinus ramaleyi, new species.

Related to **nubilipes** Say, but smaller; the thorax is entirely black; the veins of the wing are brown and much heavier than in **nubilipes,** and the first posterior cell is of

an entirely different shape, being almost as broad at its apex as at its broadest point.

Male, length, 2 mm. Head, including antennae and proboscis, black; the frontal triangle narrow, polished; the facial orbits and cheeks narrow, polished, with fine longitudinal striae. Thorax and scutellum entirely black; the dorsum opaque except along its posterior margin and clothed with scattered, appressed, flattened hairs; the posterior part of the dorsum and the scutellum shining. Abdomen black; the short third, fourth, and fifth segments, however, white, dorsally, except for small black lateral triangles; genitalia black. Legs black, the tarsi brownish-yellow. Wings hyaline, the veins brown, quite distinctly contrasting with the membrane in color; Vein R5 about three-fifths the length of that section of R4+5 from cross-vein r-m to the furcation; R5 somewhat bowed toward M1; if straightened, these two veins would be almost parallel; the first posterior cell is about as broad at its apex as at the broadest part. Halteres brown, the knob mostly white.

Female. As in the male, except that the eyes are broadly separated, the front is roughened, the abdomen is wholly shining black, and the knobs of the halteres have a considerable amount of brown on them. Length. 2.5 mm.

Holotype, male, allotype, female, Roggen, Colorado, May 29, 1937 (Helen B. James).

I take pleasure in dedicating this species to Dr. Francis Ramaley, who, several years ago, introduced me to this interesting locality.

Scenopinus fenestralis L.

Ft. Collins, Colo., July 16, 1936 (M. T. James); Boulder County, Aug. 18, 1926 (C. H. Hicks).

A FIELD KEY TO KENTUCKY WHITE GRUBS *

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Study of the white grubs (Phyllophaga) has been handicapped by the lack of field keys for identifying the various species. This has necessitated the rearing of large numbers of grubs to the adult stage, often with heavy mortality and much loss of time.

Rearing of white grubs and the study of adult May beetle distribution has been carried on by the writer in Kentucky for the past two years. In designing a field key, use has been made, firstly, of grubs reared from eggs laid by identified females and, secondly, of third stage moult skins of species reared and identified as adults.

Twenty-six species of May beetles are now known to occur in Kentucky. The most common species are **Phyllophaga hirticula** (Knoch), **inversa** (Horn), **futilis** (LeConte), **tristis** (Fab.), **hornii** (Smith), **bipartita** (Horn), **fusca** (Froehl.), **implicita** (Horn), **praetermissa** (Horn), **crenulata** (Froehl.), and **ephilida** (Say.). The fourteen species listed in the key include all the common species except **P. hornii** and four of the less common species. With the exception of **P. praetermissa, arkansana,** and **fervida** numerous specimens of the grubs of each species have been examined.

In the key only structures are used that can be made out with a binocular microscope on living or dead grubs. No dissection is necessary. The epipharynx may be examined without harm to live grubs by using a dissecting needle to turn back the labrum.

The simplest of terms have been used and where possible the best known terms have been employed. In most cases Hayes (1928) has been followed. The terms submarginal and marginal ridges are used instead of submarginal and marginal striae since striae refer to furrows between ridges and not the ridges themselves.

All the species of grubs with more or less blade-like radular spines have the majority of the bases of the

* The investigation reported in this paper is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director.

spines in each row separated by a distance as great as or greater than the width of a spine at its base. Most of the species with depressed or conical radular spines have the bases of most of their radular spines separated by a distance less than the width of a spine at its base.

It is realized that the key as presented is not perfect. Because of the variation found even in the characters of a given species, occasional grubs may not key to the correct species. Too, since the species ranges are made as broad as possible, grubs of species not included will, of course, key incorrectly.

FIELD KEY TO KENTUCKY WHITE GRUBS

1. Radular spines (Fig. 4) more or less blade-like (compressed); tips of spines turning in, often hook-like (Figs. 2a, 2b) 2

   Radular spines depressed or conical; tips never turn in but may bend out (Figs. 3a, 3b) 8

2. Thirteen or fewer radular spines in each row 3

   Fourteen or more radular spines in each row 4

3. Less than 9 radular spines in each row; submarginal ridges, two or three on each side....**P. praetermissa**

   Nine to 13 radular spines in each row; submarginal ridges very indistinct; 5 or 6 in number on each side ....**P. implicita**

4. Five or fewer indistinct submarginal ridges on each side; ridges often appear to be absent 5

   Five to more than ten well developed submarginal ridges on each side (Fig. 1) 6

5. Less than 18 radular spines in each row..**P. arkansana**

   More than 20 radular spines in each row....**P. inversa**

6. Radular spines distinctly blade-like (Figs. 2a, 2b), tips more or less hook-like 7

   Radular spines not distinctly blade-like, but tips turn in ....**P. ephilida**

7. Nine or more submarginal ridges on each side .... **P. fusca**

   Five to 8 submarginal ridges on each side.. **P. fervida**

8. Fewer than 10 submarginal ridges on each side 9

   Ten or more submarginal ridges on each side 13

9. Submarginal ridges absent. Sparse, radular rows of from 10 to 13 spines curved to form a wide oval .... **P. tristis**

   Submarginal ridges present 10

10. Three to 4 small, short, submarginal ridges.. **P. micans**

    Six to 9 submarginal ridges 11

11. Six, or rarely 7, well developed submarginal ridges .... **P. bipartita**

    Seven to nine submarginal ridges on each side 12

12. Radular spines very long and sharp, at least 4 times as long as the width of their bases .... **P. futilis**

    Radular spines shorter and usually blunter............ **P. hirticula**

13. Twenty-two or fewer radular spines in each row .... **P. crenulata**

    More than 23 radular spines in each row.... **P. prunina**

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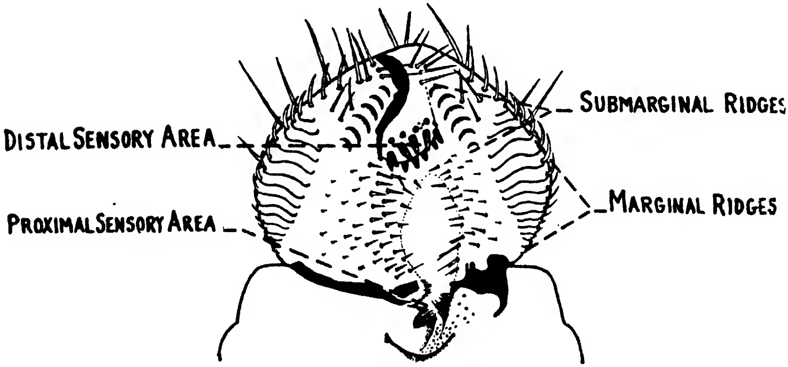
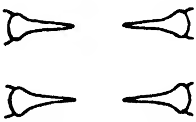
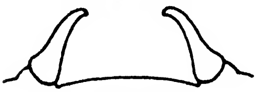


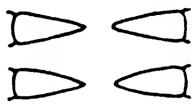
1. EPIPHARYNX



2a. RADULAR SPINES BLADE-LIKE

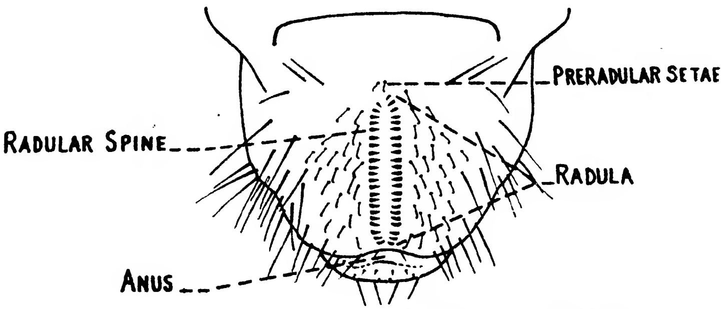


2b. SIDE VIEW



3a. RAD. SPINES DEPRESSED

3b. SIDE VIEW



4. LAST SEGMENT OF GRUB, VENTRAL VIEW

A NEW GRAPTOCORIXA FROM MEXICO (CORIXIDAE-HEMIPTERA)

H. B. HUNGERFOORD, Lawrence, Kansas *

In a collection of several hundred Corixidae made by Mr. Henry Thomas in Mexico during the summer of 1936, I find three specimens of an unusually interesting species which I describe below:

Graptocorixa thomasi n. sp.

Size: 9.9 mm. long; width across head from 3.15 mm. to 3.24 mm., which makes it a moderately large and broad species.

Color: General facies moderately dark. In one specimen only the venter of the prothorax is dark, in another the venter of the thorax and the basal abdominal segments are nearly black. Pronotum crossed by thirteen or fourteen dark bands that are, on the whole, slightly narrower than the pale interspaces. Corium and clavus crossed by transverse wavy bands; on the inner angles of the clavus, the pale bands are broader than the dark ones—elsewhere the reverse is true, except at the tip of the corium where there is an ill-defined pale area; the membrane is crossed by undulate bands; embolium sooty black.

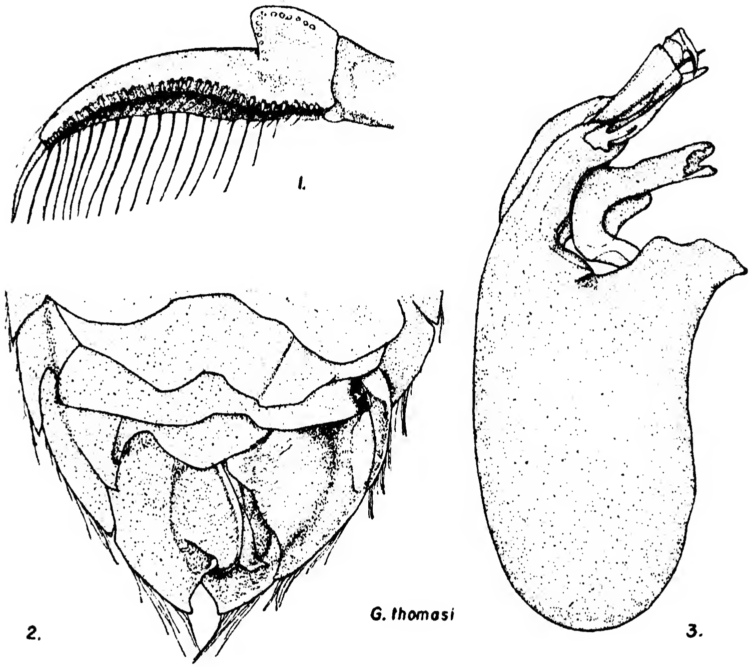
Structural Characters: Face somewhat narrowed but not as greatly reduced as in some species of the genus. Facial depression of male very slight and but sparsely covered with hairs. Hemelytra with corium and clavus rastrate. Metaxyphus long and slender.

* Contribution from Department of Entomology, University of Kansas.

Anterior femora of females of nearly uniform diameter, near the middle the caudal margin is produced and bears a row of four or five long bristles. In the male the anterior femora are conspicuously and angularly produced near the middle of the caudal margin, and on the inner surface at this point is a transverse ridge from the distal side of which are five stout curved bristles. The pala of the male is shown in the figure, its peculiar shape making this a readily recognized species; the pala of the female is typical of the genus; the tarsus of the middle leg conspicuously longer than the tibia; the tibia of posterior leg with anterior margin distally produced and spine tipped; the first tarsal segment relatively broad. The dorsal side of the abdomen of the male as shown in the drawing. The strigil consists of two rows and the caudal lobes of the abdomen have the inner margins curiously modified into broad, more or less hook-like structures. The male genital capsule and its parts unusually complicated as shown in the figure.

Location of Types: Holotype, allotype and one paratype (male) in Francis Huntington Snow Collection, University of Kansas. They are labeled "El Sabino, Uruapan, Mich., Mexico, Aug. 2, 1936. H. D. Thomas."

Comparative Notes: Among other of the larger species of the Genus Graptocorixa this one may be recognized by its comparative short body. The unique shape of the male pala and the elongate middle tarsus readily characterize the species.



Text figure 1.—Graptocorixa thomasi Hungerford

1. Pala of male. 2. Abdominal dorsum of male. 3. Male genital capsule.

TWO NEW SPECIES OF LONATURA (HOMOPTERA-CICADELLIDAE)

R. H. BEAMER, Lawrence, Kansas*

Lonatura megalopa Osborn and Ball

Lonatura megalopa O. & B. Proc. Dav. Acad. Sci., vii, p. 85, pl. 4, fig. 1, 1898.

Three pairs of cotypes from the collection of Iowa State College have been examined together with 15 specimens from Russell, Manitoba, collected August 1, 1937, now in the Snow Entomological Collections. As far as I am aware, this is the first time this species has been taken since the original series.

Internal male genitalia: Style very heavy at middle, tapered toward either end, apical sixth strongly narrowed and bent out. Pygofer narrowed into a sharp tooth at outer ventral corner. Aedeagus in dorso-ventral view bulbous at base, narrowing to a slightly bifid apex, with a short, sharp, lateral tooth either side near tip; in lateral view, very broad on basal half, with large angular hump on ventral margin, abruptly narrowed to rather slender shaft, bent dorsally almost at right angles on outer fourth.

The male described above is here designated Lectoholotype and the female figured Lectoallotype. In the collection at Iowa State College, Ames, Iowa.

This species was referred doubtfully to Lonatura by the authors. It has since been placed in the genus Deltocephalus. After careful study of the above specimens and those of the following species, I am of the opinion that they are more closely related to certain species of Lonatura than to those of Deltocephalus. It is possible they belong to an undescribed genus, but for the present it seems best to leave them in Lonatura.

Lonatura punctifrons n. sp.

Resembling **Lonatura megalopa** O. & B., but slightly smaller, markings of vertex not so extensive, color of front mostly confined to a large black spot, last ventral

* Contribution from Department of Entomology, University of Kansas. Illustrations by Miss Maxine Graham.

segment of female decidedly more excavated on lateral margins, median projection of posterior margin not notched and aedeagus of male with a long, very slender, forward projecting spine just beyond middle on ventral side. Length ♀ 2.75, ♂ 2.25 mm.

Vertex conical, margins rounded. Elytra short, exposing at least six abdominal segments, apices truncate, costal margin longest, apical cells absent in short winged forms; hind wings reduced to rounded pads.

General ground color yellowish brown. Vertex with two small triangular black spots at apex, two much larger, irregular-sided black spots posterior to these and an indefinite short, dark dash near each eye at base. Pronotum and elytra almost hyaline, veins lighter, rarely slightly margined with fuscous; abdominal segments cross-banded as follows: basal black, median brown and outer cinereous. Front with median dark spot and an almost solid dark band connecting eyes.

Genitalia: Last ventral segment of female three times as long as preceding, lateral margins strongly excavated from base, exposing underlying membrane, posterior margin almost straight to short median strap-like process. Valve of male slightly longer than preceding segment, angular; plates wider than valve at base, sinuately narrowed on outer margin to sharp apices; aedeagus in dorso-ventral view enlarged at base, narrowed to long slender tip, in lateral view with very long base, slightly curved dorsally, narrowed to slender, slightly enlarged apex with a slender, very sharp forward projecting spine on ventral margin one third distance from tip.

Holotype male, allotype female, and four pairs of paratypes, Lake City, Colo., June 29, 1937, R. H. Beamer; 4 long-winged ♀s and 2 short-winged ♂ paratypes, Pingree Park, Colo., Aug. 10, D. A. Wilbur. Types and paratypes in Snow Entomological Collection; paratypes in Kansas State College Collection.

Lonatura delicata n. sp.

Resembling **Lonatura punctifrons,** but distinctly smaller, without the black spot on front and with the last ventral segment of female with lateral margins more roundingly excavated and the posterior margin rounded

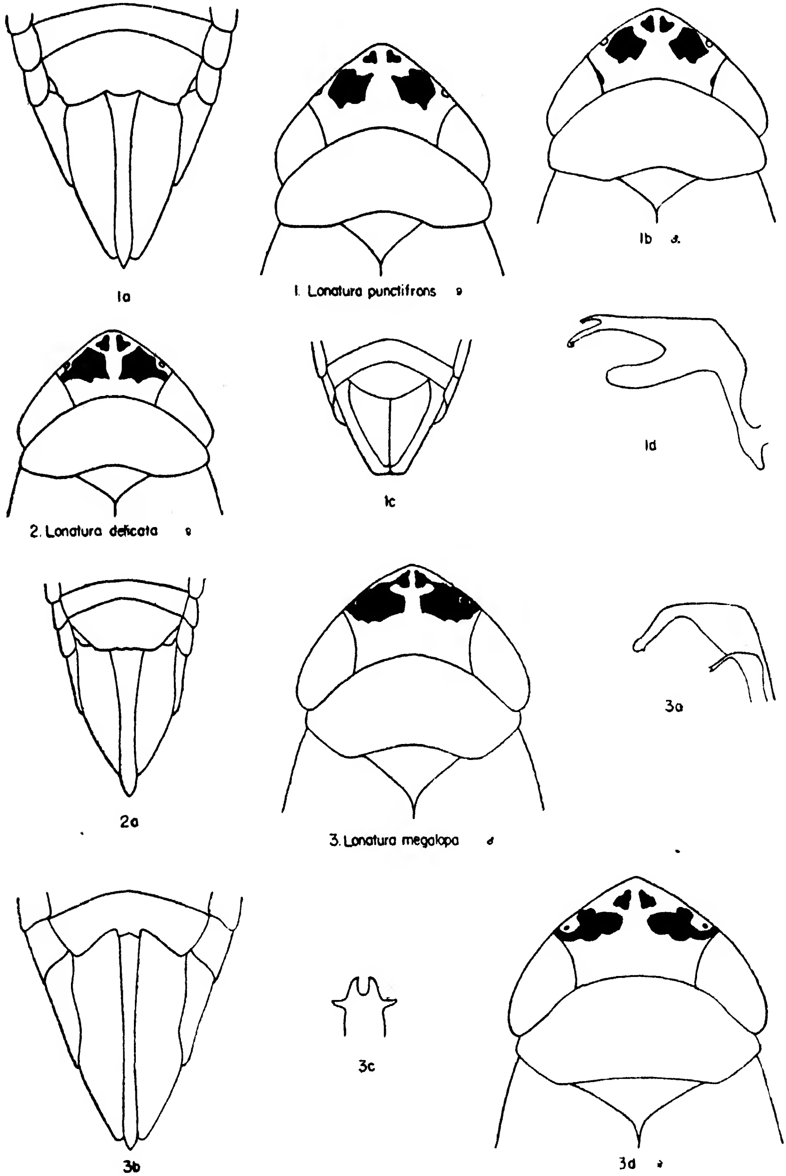
without the definite median strap-like process. Length ♀ 2.5 mm.

Vertex slightly longer than wide, conical, margins curved. Elytra short, exposing 6-7 segments of abdomen, apices truncate, costal margin longer, venation distinct; much reduced, apical cells absent, hind wings reduced to small pads.

General ground color yellowish brown; vertex with two small black triangles at apex and two much longer black spots back of these; pronotum and wings semi-hyaline; dorsum of abdomen with last segment black, penultimate two thirds black and others with lateral black spot occupying about basal two thirds; face evenly buff-colored, slightly suffused with darker brown; venter of abdomen more or less black.

Genitalia: Last ventral segment of ♀ about 3 times as long as preceding, lateral margins deeply excavated almost to base, lateral angles broadly rounded to almost truncate posterior margin with only a slightly bilobed indication of median strap-like process; underlying membrane broadly exposed at outer corners.

Holotype ♀ and 1 ♀ paratype, Silver City, New Mexico, July 22, 1936, R. H. Beamer. In Snow Entomological Collection.


1a
1. Lonatura punctifrons ♀
1b ♂
2. Lonatura delicata ♀
1c
1d
2a
3. Lonatura megalopa ♂
3a
3b
3c
3d ♀

KANSAS ACADEMY OF SCIENCE 1938 MEETING

The 70th annual meeting of the Kansas Academy of Science will be held at the Kansas State Teacher's College, Pittsburg, Kansas, on March 31, April 1 and 2, 1938. The Secretary, Dr. Roger C. Smith, has just announced the meeting dates as decided by the committee on arrangements, of which Professor William Matthews of Pittsburg is chairman, and of the executive council. The Kansas section of the American Association of University Professors and two sections of the Kansas Mathematical Society are expected to meet with the Academy at that time. The Kansas Entomological Society voted recently to meet at Pittsburg with the Academy. The committee of arrangements is making more than usual efforts to secure leading speakers for the two evening lectures. Field trips to lead and zinc mines and coal strip mines of the region will be provided.

The 1936 volume of the Transactions of the Academy which is volume 39 was distributed to the members and co-operating libraries in August. There is a possibility that volume 40 will be printed and distributed before the close of 1937. Thirty-seven applications for membership in the Academy since April 7th were lately placed before the membership committee.

THE DEAN-NABOURS CELEBRATION.

Prof. Geo. A. Dean, head of the Department of Entomology, and Dr. R. K. Nabours, head of the Department of Zoology, of the Kansas State College of Agriculture and Applied Science, Manhattan, Kansas, were honored on October 1 and 2 at a joint celebration upon the completion of 25 years as heads of their respective departments. Dr. H. B. Hungerford, head of the Department of Entomology, University of Kansas, Lawrence, Kansas, gave the opening address at a special meeting of the Zoology-Entomology Seminar on Friday, October 1, on the subject "Interesting Aspects of World Distribution of Aquatic Hemiptera". Dr. Paul S. Welch, member of the entomological staff of Kansas State College from 1913 to 1918, now Professor of Zoology, University of Michigan, Ann Arbor, Mich., gave an illustrated address in the evening on the subject "The Oxygen

Balance in Inland Waters and the Hazards of Aquatic Respiration". The two departments held "open house" on Saturday afternoon, October 1, displaying the major accomplishments of 25 years and research work now in progress. A special bulletin (Kansas State College Bulletin, Vol. 21, No. 9, 55 pp., 1937) giving biographies of Professors Nabours and Dean, a survey of the accomplishments, and titles of all published papers from the two departments in the 25 years, was first distributed at the banquet. A bound volume of letters from students and friends also was presented to each of them at the banquet.

NOTICE

The Fourteenth Annual Meeting of the Kansas Entomological Society will be held April 2, 1938 at the Kansas State Teachers College, Pittsburg, Kansas.

~~Members wishing to present papers should submit titles to the Secretary not later than March 15, 1938.~~

H. H. Walkden, Secretary-Treasurer
1204 Fremont St.,
Manhattan, Kansas.

Correction—Members wishing to present papers should submit titles to the Secretary not later than March, 1, 1938.

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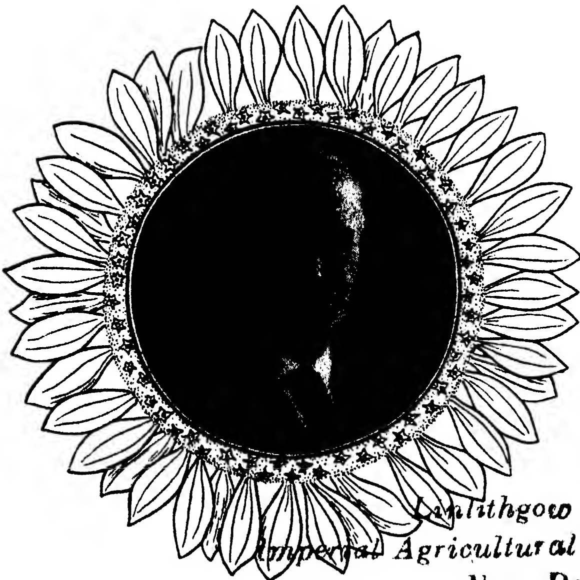

WARREN KNAUS

1858-1937.

Entered as second-class matter December 31, 1927 at the Post-Office at McPherson, Kansas, under the Act of August 24, 1912.

Kansas Entomological Society

Vol. 11, No. 2. April, 1938

ORNIX PRUNIVORELLA CHAMBERS (LEPIDOPTERA, TINEIDAE), A PEST OF THE APPLE TREE IN THE LOWER MISSOURI RIVER VALLEY REGION.*

L. M. COPENHAFER** and RALPH L. PARKER,
Kansas Agricultural Experiment Station.

Introduction

The existence of a leaf-mining insect in the Kansas Agricultural Experiment Station orchard at Manhattan was the reason for the investigation of this problem. Later the damage of this insect was found in the apple growing region of North-eastern Kansas. Since the specific insect was unknown at the beginning of the work, three objectives were set forth as follows: (1) to determine the insect or insects causing the damage, (2) to study the biology of the insect or insects, and (3) to find an effective means of control. The insect was later determined as **Ornix prunivorella** Chamb.

Economic Importance

This is one of many insects of secondary economic importance. Infestations of a serious nature occur sporadically and are usually of importance for only a few years. The larvae injure the foliage by feeding between the epidermal layers of the leaf.

Historical Considerations

Most of the papers dealing with this insect are short and have been written about one phase, such as, habits, description, taxomony or control of **Ornix prunivorella** Chamb. Probably, the most valuable paper on life history of this insect for the Lower Missouri River Valley Region is that of Haseman (1916).

Distribution

This insect has been reported from the following states: Packard (1869), New England group; Forbes

*Contribution No. 456 from the Department of Entomology.
**Assistant Landscape Architect, Kansas Highway Commission.

(1887), Michigan, Illinois; Chambers (1877), Colorado; Brunn (1883), New York; Chambers (1873), Kentucky; Gossard (1911), Ohio; Haseman (1911), Missouri; Luggar (1899), Minnesota; Ross and Caesar (1920), Niagara districts and Norfolk county in Ontario, Canada; Severin (1922), South Dakota and Arkansas besides being reported by the authors for Kansas. No reference was found that dealt with its life history or habits under Kansas conditions.

Larvae of this insect were first collected west of Manhattan, Kansas, at the Kansas Agricultural Experiment Station Orchard in 1933, also in the summer of 1934, near Ogden in Riley county, Kansas and during the summers of 1934 and 1935 in the vicinity of Eskridge, Kansas. During 1934-35, larvae were collected in the vicinity of Troy and Wathena in Doniphan county, Kansas. In Doniphan, Atchison, and Leavenworth Counties it was present in 1936, and during 1937 it caused serious damage.

Synonymy

This insect has several synonymous, scientific and common names. Dr. Annette F. Braun, University of Cincinnati, Cincinnati. Ohio, determined the reared insects to be **Ornix prunivorella** Chamb.

The accompanying Table 1, shows the different scientific and common names that have been used in the literature in relation to this insect.

Hosts

Although the leaves of several species of fruit trees are attacked by **Ornix prunivorella** Chamb., this paper deals especially with the infestation on apple trees **(Pyrus malus)**. Apple trees are by far the favorite host of **Ornix prunivorella** Chamb. All of the varieties (62) of apple trees in the Kansas Agricultural Experiment Station orchard were found to be infested (a list of these are on file in the Department of Entomology). All varieties of quince **(Cydonia ablonga)** and pears **(Pyrus communis)** grown in the Kansas Agricultural Experiment Station orchard, were found to be heavily infested. Infested leaves were also found on the sour cherry **(Prunus cerasus)** and seedling cherry stock **(Prunus mahaleb)**. No infested leaves were observed on sweet cherry **(Prunus avium)** or cultivated plum **(Prunus sp.)**.

Table 1

Synonymy

Ornix prunivorella Chambers

Table Showing Inconsistencies of Nomenclature in the Literature

Scientific Name	Common Name	References	Remarks
Lithocolletis geminatella Pack.		Packard (1869)	Original description.
Ornix prunivorella Chamb.		Chambers (1873)	Original description by Chambers.
Ornix prunivorella Chamb.		Walsingham (1882)	On two species of **Lithocolletis geminatella** Pack.
Ornix prunivorella Chamb.	Unspotted Tentiform Miner of Apple	Brunn (1883)	Life history and habits in New York.
Ornix prunivorella Chamb.	Apple Leaf Creaser	Weed (1888)	On synonymy **Ornix prunivorella** and **geminatella** same.
Ornix geminatella Pack.	The Apple Ornix	Forbes (1889)	Notes on life history and habits of insect.
Lithocolletis geminatella Pack.	Pear and Apple Tree Leaf-Miner.	Luggar (1899)	Notes on habits of insect.
Ornix geminatella Pack.	Wild Cherry Leaf Miner	Luggar (1899)	Notes on habits of insect.
Ornix geminatella Pack.	Pear Leaf Miner	Gossard (1911)	Notes on infestation of apple and pear in Ohio.
Ornix prunivorella Chamb.	Spotted Tentiform Leaf Miner	Haseman (1911)	Notes on infestation and report.
Ornix geminatella Chamb.	Unspotted Tentiform Leaf Miner	Haseman (1916)	Life history study.
Lithocolletis prunivorella Chamb.		Haseman (1916)	Paper on **Ornix geminatella** Pack.
Parornix prunivorella Chamb.		Forbes (1923)	**Parornix prunivorella** Chamb. and **Parornix geminatella** Pack. are listed as doubtful synonymy
Parornix geminatella Chamb.		Forbes (1923)	
Parornix		Leonard (1926)	Classification of Hubner in "Tentamen."
Parornix prunivorella Chamb.		Needham - Frost-Tuthil (1928)	Account in book devoted to "Leaf Miners".
Ornix prunivorella Chamb.	Unspotted Tentiform Leaf Miner		Identification of insect by Dr. Annette F. Braun in 1934.

Character of Injury

Pear (**Pyrus communis**) leaves examined showed that little of the tissue forming the palisade cells had been eaten by the larva, however, the lower epidermis covering of the mine was frequently dark brown or black color. All apple trees were heavily infested. The ones having large succulent, hairy leaves that send out vigorous new growth were likely to be more heavily infested than trees having thin, shining, leathery leaves that send out little new growth.

In the early stage of making the mine, the larva feeds between the epidermis and eats the mesophyll cells and tips of the palisade cells, thus constructing its mine and removing all tissue within, leaving only the upper and lower epidermis to form the mine.

Leaf burning was found after the application of the arsenical sprays. It is the contention that extremely high temperatures, lack of moisture, and arsenical spray residue are the factors that cause the burning of the leaf around the insect mine. When these factors were not present which affect the physiological condition of the leaf, this kind of burning was not observed.

Methods and Procedure

Several different insecticides were used during the season of 1933. The experimental plots were selected for research in the codling moth (**Carpocapsa pomenella L.**) control insecticide test plots.* Drought conditions prevailed this year in Eastern Kansas.

On the several plots the following stomach poison insecticides were used at the rate of 3 pounds to 100 gallons of water: astringent lead arsenate, non-astringent lead arsenate, manganar (manganese arsenate), Dutox (barium fluosilicate), and Kalo (sodium alumninum fluoride). Calcium arsenate was used at the rate of 2 pounds plus 2 pounds of lime. The first 3 cover sprays in the manganar, Dutox and Kalo combinations were non-astringent lead arsenate.

In another set of plots were used the contact insecticides. These were combinations of lead arsenate, used

* Thanks are due to Dr. Geo. A. Filinger of the Horticulture Department for the cooperative use of spray data and to the Department of Horticulture for the use of the Kansas Agricultural Experiment Station orchard.

for the first 3 cover sprays and at the rate of 3 lbs. to 100 gallons of water, and organic compounds for the remaining 4 cover sprays. The mixtures were made up on the basis of 100 gallons of water. The 3 organic compounds used were 40% nicotine sulphate 1 pt. plus summer oil emulsion (Verdol) 1 gallon, nicotine tannate (40% nicotine sulphate 1 pt. plus tannic acid 3 pts.) and oleic acid 1 pt. plus summer oil emulsion (Verdol) 1 gallon. Following the calyx spray of lead arsenate there were seven sprays applied to all plots. The first cover spray was applied between May 1 and 6; the second, between May 15 and 22; the third, between May 30 and June 2; the fourth, between June 26 and 28; the fifth, between July 11 and 12; the sixth, between July 31 and August 1; and the seventh, between August 19 and 26.

Leaf counts were made to determine the effectiveness of using stomach poison and contact insecticides as shown in Tables 2 and 3.

RESULTS OF EXPERIMENTAL WORK

Biology of Insect

Leaves infested by larvae of the insect were found in June, 1933 at which time the biological work began.

The cylindrical, fine meshed, copper wire, insect cage (Plate 1, Figure 7) was quite satisfactory for life history work. Two adult moths emerged from two of these cages that were placed in contact with the ground and with the soil covered with fallen leaves (Plate I, Figure 9). The insects emerged April 7, 1934. A successful type of cage for rearing larvae was a paper sack with a moist cloth or sponge placed inside with the infested leaves. The most successful type of insect cage for carrying the insect through the winter, was the upright glass cylinder that was placed several inches into the soil and had the top covered with muslin (Plate I, Figure 8).

Life stages

Egg

Plate II, Figure 7 shows a magnified drawing of the egg. Its size varies from 0.254 to 0.4 mm. in length and from 0.18 to 0.29 mm. in breadth. The eggs are laid singly on the under surface of the leaf, but it appears that no particular spot is chosen to receive the egg.

On August 27, 1933, 15 adult **Ornix** moths were placed in a 4-inch glass vial. On September 3, the embryonic larvae were apparently ready to leave the shell and could plainly be seen curved inside the egg shell (Plate II, Figure 9).

Larva

Plate II, Figure 10 shows the newly hatched larva which is footless. In its development it passes through four district instars. When the larva is full grown it is 6 to 7 mm. in length. The head is light brown and the first thoracic segment is light yellow besides having 4 characteristic black spots. Plate II, Figure 12 shows it as a gray caterpillar which has conspicuous white tubercles on the body and six thoracic legs besides abdominal legs.

The Mine and Larval Life

The newly hatched larva makes a serpentine mine (Plate II, Figure 1). This mine goes through a transition which corresponds to the changes of the 3 larval instars (Plate II, Figures 10, 11, 12). This serpentine mine averages from 4 to 10 mm. long. The blotch mine is evident about the time the larva changes to the second instar. This appears on the under side of the leaf and the epidermis is loosened from the palisade cells by the feeding of the flat footless larva. This loosened epidermis soon dies and turns brown. After the blotch is formed the larva starts feeding at one end of the mine, consuming the palisade cells and all tissue between the lower and upper epidermis. There are no green spots, caused by the remaining of part of the tissue of the inner leaf in the insect mine. This habit is responsible for the descriptive part of the common name which is "unspotted".

The larva produces the tentiform mine by spinning silk threads on the floor of the mine which causes the lower dead layer of the leaf to become folded lengthwise of the mine. The larva usually leaves the mine by an opening in the under surface and either prepares a cocoon in which to pupate on the same leaf or goes to a different one. During midsummer, the larval life in the mine is about ten days to two weeks.

Pupa

The mature larva transforms into a pupa which is about 5 mm. long. The color varies from light yellow to

dark brown as the time approaches for it to transform into the moth (Plate II, Figure 14).

Adult

The adult moth is a striking little creature after one has become acquainted with its characteristics and habits (Plate II, Figure 16). To the naked eye, the moth is slate gray with a light tinge of brown, (Plate II, Figure 15).

Life history

Data collected indicate that this insect over-winters in both the larval and pupal stages. The fourth instar larvae were observed in insect cages in the field as late as February 15, 1934.

Adult moths emerged in rearing cages on April 7, 1934. It was about a month later when infestations in the field could be readily found. Six adult moths were placed on a potted apple seedling (Plate I, Figure 10) and in a ten day period from the time of mating, well developed mines were found (Plate II, Figure 6). Mating of the insects was observed in a glass vial on August 2, 1933, the insects joined the posterior ends of their bodies in copulation and remained in this position for approximately 30 minutes.

The following inclusive dates are representative for the beginning of the seasonal broods, for the 1933 season, showing an average length of life cycle of 27 days, with a range of 18 to 35 days: Brood 1—April 5 to 9; brood 2—May 10 to 14; brood 3—June 15 to 19; brood 4—July 12 to 16; brood 5—August 3 to 7; brood 6—August 25 to 29; brood 7—September 12 to 16; and brood 8—October 12 to 16. The large number of broods was undoubtedly due to the warm rains in the fall as green apple leaves infested with larvae were collected in the field as late as December 19, 1933.

Applied Control

Leaf counts were made to determine the effectiveness of using stomach poison sprays and contact insecticides as shown by Tables 2 and 3. Effectiveness of insecticides in the control of the leaf miner is shown by the comparative freeness from insect injury in the various chemical spray treatments. Additional spray chemical injury to the leaves is shown by the burning of leaf tissue adjacent to the leaf miner injury.

Table 2

Relative Burning of Mines by Stomach Poisons per 1200[1] Apple Leaves Infested by **Ornix prunivorella** Cham.

Variety, spray and month, day, and year of examination	Number of Mines			Percent of mines		Average Leaf Infestation in per-cent
	Burned*	Not Burned	Total	Burned*	Not Burned	
Stayman Winesap Manganar 10-5-33	2952	99	3051	96.76	3.24	2.46 Nine mines found on 1 leaf
Stayman Winesap Manganar 10-5-33	2304	48	2352	97.96	2.04	1.92
Stayman Winesap Manganar 10-5-33	2550	48	2598	98.15	1.85	2.13
Jonathan Astr. Lead Ars. 9-12-33	1500	51	1551	96.71	3.29	1.25
Maiden Blush Lead Ars. 9-12-33	999	177	1176	84.95	15.05	.83
Wealthy Lead Ars. 10-17-33	1359	0.0	1359	100.00	0.0	1.13
Wealthy Lead Ars. 10-17-33	1710	9	1719	99.48	.52	1.43
Rome Beauty Lead Ars. 10-1-33	1337	56	1393	95.98	4.02	1.11
Anoka Lead Ars. 10-5-33	513	252	765	67.06	32.94	.43
Pear Lead Ars. 10-17-33	201	6	207	97.10	2.9	.17
Winesap Kalo 10-17-33	522	9	531	98.31	1.69	.44
Winesap Kalo 10-17-33	982	0.0	982	100.00	0.0	.82
Winesap Dutox 9-28-33	178	11	189	94.18	5.82	.15
Winesap Dutox 9-28-33	234	11	245	95.51	4.49	.20
Winesap Dutox 9-28-33	274	9	283	96.82	3.18	.23
Winesap Cal. Ars. 10-12-33	837	120	957	87.46	12.54	.70
Winesap Cal. Ars. 10-12-33	513	48	561	91.44	8.56	.43

*Burned—leaf mine injury in which spray material has entered and killed additional tissue around the insect mine.

1 In certain instances there is more than one mine per leaf, in one case there were 9 mines per leaf — see percentage of leaf infestation (last column).

Table 2 (Concl.)

Variety, spray and month, day, and year of examination	Number of Mines			Percent of mines		Average Leaf Infestation in per cent
	Burned*	Not Burned	Total	Burned*	Not Burned	
Winesap Cal. Ars. 10-12-33	471	72	543	86.74	13.26	.39

Table 3

Relative Burning of Mines by Contact Insecticides per 1200[1] Apple Leaves Infested by **Ornix prunivorella** Cham.

Variety, spray and month, day, and year of examination	Number of Mines			Percent of mines		Average Leaf Infestation in per cent
	Burned*	Not Burned	Total	Burned*	Not Burned	
Winesap Nic. Tan 10-1-33	282	18	300	94.00	6.00	.24
Winesap Nic. Tan. 10-1-33	204	8	212	96.23	3.77	.17
Winesap Nic. Tan. 10-12-33	426	15	441	96.60	3.40	.36
Winesap Nic. Sul. + Oil 9-12-33	231	3	234	98.72	1.28	.09
Winesap Nic. Sul. + Oil 9-12-33	138	3	141	97.87	2.13	.12
Winesap Nic. Sul. + Oil 9-28-33	91	17	108	84.26	15.74	.08
Winesap Nic. Sul. + Oil 9-28-33	55	7	62	88.71	11.29	.05
Winesap Nic. Sul. + Oil 9-28-33	69	10	79	87.34	12.66	.06
Winesap Oleic Acid + Oil 10-7-33	405	81	486	83.33	16.67	.34
Collins Oleic Acid + Oil 10-7-33	621	133	754	82.36	17.64	.52

* Burned—Leaf miner injury in which spray material has entered and killed additional tissue around the insect mine.

1 In certain instances there is more than one mine per leaf, in one case there were 9 mines per leaf—see percentage of leaf infestation (last column).

It is noted that the percent of leaf infestation is much greater where the arsenicals or stomach poison insecticides were used, namely, 0.15 to 2.46 percent as compared to that where the nicotine compounds were used, namely, 0.05 to 0.24 percent. Stated in another way, the infestation of leaves which were sprayed with stomach poisons ranged from 1 larva per 7 leaves to 2.46 larvae per leaf. The infestation of leaves sprayed with contact insecticides ranged from 1 larva per 20 leaves to 1 larva per 4 leaves.

It will be noted in Table 3 that the infestation and leaf injury is remarkably less where contact insecticides were used. The 40% nicotine sulphate-summer oil emulsion produced the most effective control.

Biological Control

A number of hymenopterous parasites of **Ornix prunivorella** Chamb. were reared while carrying on the life history studies of this insect. At the time this study was made the infestation at Manhattan, Kansas was at its peak, and the parasites were well established (Plate II, Figures 17 and 18). Seven species of parasites were determined from the collection submitted to Dr. Harold Morrison, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture. There was also evidence that internal parasites attacked the larvae and emerged from the pupae.

Those parasites identified by A. B. Gahan on June 5, 1934 were:

Elasmus albicoxa Howard
Zagrammosoma multilineata (Ashm.)
Cirrospulus nigrovariegata Gir.
Sympeisis bimaculata Cwfd.
Catolaccus aeneoviridis (Gir.)
Horismenus fraternus (Fitch)
Tetrastichus caerulescens Ashm.

C. F. W. Muesebeck determined the following on March 14, 1934:

Apanteles tischeriae Vier.
Epirhyssalus new species.

Muesebeck (1935) described the above new species in a new genus and species. He placed this new species

that was previously in the genus **Epirhyssalus** in the new genus **Xenosternum.** The species is named **Xenosternum ornigis** Mues. which is also the type species.

Cultural and Mechanical Control

To decrease the number of emerging insects in the spring, disking or cultivating is necessary in the fall or winter. This destroys the pupae in cocoons attached to the fallen leaf or the larvae within the leaf mine. Burning leaves is also a method used to control insects as well as plant diseases.

DISCUSSION AND CONCLUSIONS

The unspotted tentiform leaf miner may infest from 90 to 95 percent of the leaves of the apple tree with from 1 to 9 mines per leaf. In addition to this injury caused by the feeding of the insect is another injury brought about directly by the presence of these insect mines, namely, spray burn.

In years past, this insect has been considered as one of minor economic importance, due probably to the following facts:

1. No insect injury is caused directly to the fruit.
2. Inferior quality of fruit is caused indirectly by damage to the foliage.
3. This insect is heavily parasitized when a serious outbreak occurs and becomes harmful. It is usually checked by its natural enemies within a few years.

Since the sprays in this experimental work were timed and applied for the control of the codling moth, the nicotine insecticides were applied in the last 4 cover sprays, and the nicotine sprays also controlled the leaf miner, it appears that such insecticides applied with or as codling moth control measures will also control the unspotted tentiform leaf miner without additional spraying operations.

More consideration should be given this insect as being one of the harmful orchard pests, especially since stomach poison sprays are of little comparative value for the control of this insect. These sprays caused more injury to the already insect injured foliage in 1933 and 1934 than did the insect. The use of a 40% nicotine sul-

phate summer oil emulsion spray reduced markedly the infestation of this pest. The following combinations are also recommended:

1. Cultural practices such as fall plowing and burning of leaves.
2. Summer spraying with 40% nicotine sulphate summer oil emulsion.
3. Encourage whenever possible, the establishment of the parasites of this pest.

SUMMARY

1. A leaf mining insect infesting apple trees in the Kansas Agricultural Experiment Station orchard at Manhattan, has been determined as **Ornix prunivorella** Chamb. This insect is well distributed in Eastern Kansas.
2. This insect had not been reported from Kansas before November 6, 1933 at which time, Dr. Annette F. Braun of the University of Cincinnati, made the identification.
3. This insect overwinters in both the larval and pupal stages. A life cycle is completed in 4 to 5 weeks during the summer.
4. The larvae of this insect eat the inner leaf tissue and in this way make the mines. Spray materials enter the leaf at points of injured leaf tissue and in this way, cause an additional injury known as spray burn.
5. Stomach poison sprays are of little comparative value in the control of the larval stage of this moth.
6. The use of a 40% nicotine sulphate summer oil emulsion spray reduced the infestation of this pest more than did the other insecticides.
7. There have been reared and identified, 9 different hymenopterous parasites from **Ornix prunivorella** Chamb., one of which is a new species and genus, it being the type species for the new genus.
8. The apple **(Pyrus malus)** is the favorite host plant of this injurious insect.

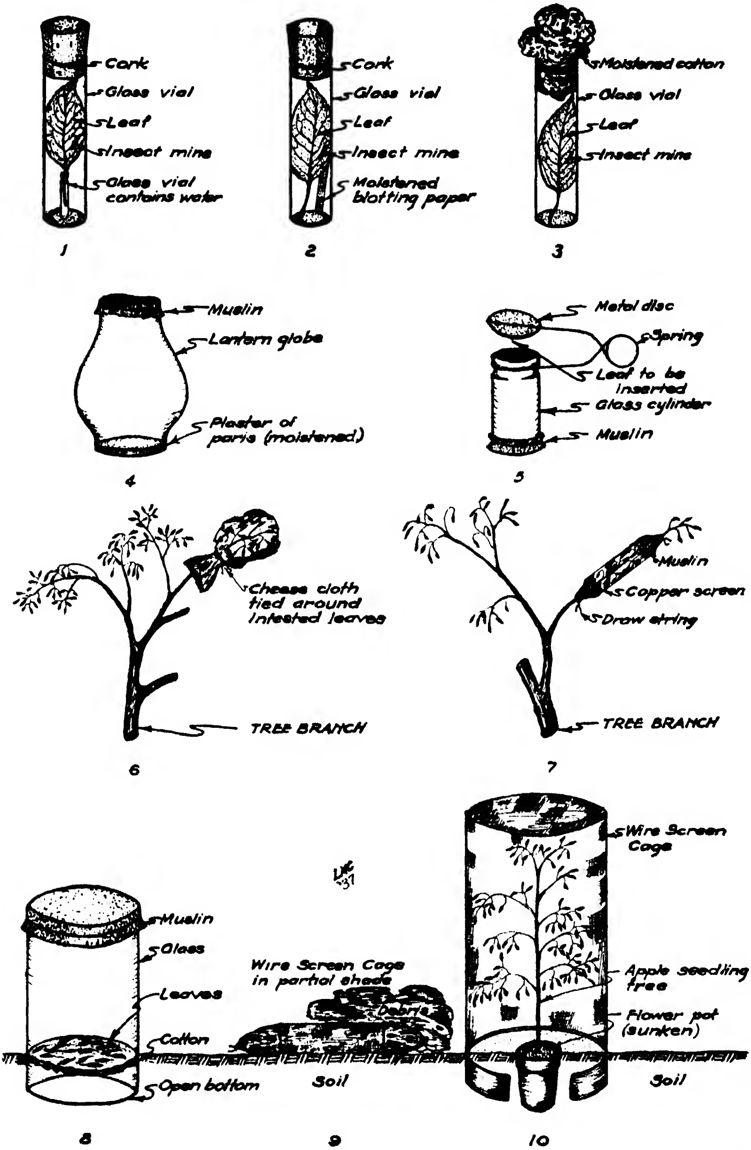

Plate I—Insect Rearing Cages used in Life History Studies of **Ornix prunivorella** Chamb.

Plate I

1. Double glass vial insect rearing cage.
2. Glass vial insect rearing cage, end closed with cork stopper.
3. Glass vial insect rearing cage, end closed with cotton.
4. Lantern globe insect rearing cage.
5. Glass cylinder rearing cage that clamps on the leaf.
6. Cheese cloth insect rearing cage.
7. Cylindrical wire screen insect rearing cage tied on branch of tree.
8. Glass cylinder insect rearing cage.
9. Cylindrical wire screen cage in contact with the soil.
10. Cylindrical wire screen cage covering potted apple seedling tree.

Plate II

1. Apple leaf serpentine mines shortly after eggs had hatched (Drawn from photograph taken on September 5, 1933). 1x.

2. Apple leaf (a) cross section of mine showing (b) hole where larvae entered (c) section of larva in center (Drawn from photograph taken in July, 1934). 67x.

3. Apple leaf, under surface showing injury by the leaf-mining habit (the mine itself) and distortion of the leaf by rolling and tying (Drawn from photograph taken on July 14, 1933). 2/3x.

4. Apple leaf under surface showing injury by the leaf miner (Drawn from photograph taken July, 1933). 1/3x.

5. Apple leaves upper surface showing injury by leaf mining habit and charäcteristic location on leaf (Drawn from photograph taken on July 14, 1933). 2/3x.

6. Apple seeding in pot, showing injury of leaves by the leaf mining habit (Drawn from photograph taken in May, 1933).

7. Egg highly magnified (binocular highpower) and showing the grid of cross hairs of the microscope for comparison of size (diagrammatic drawing).

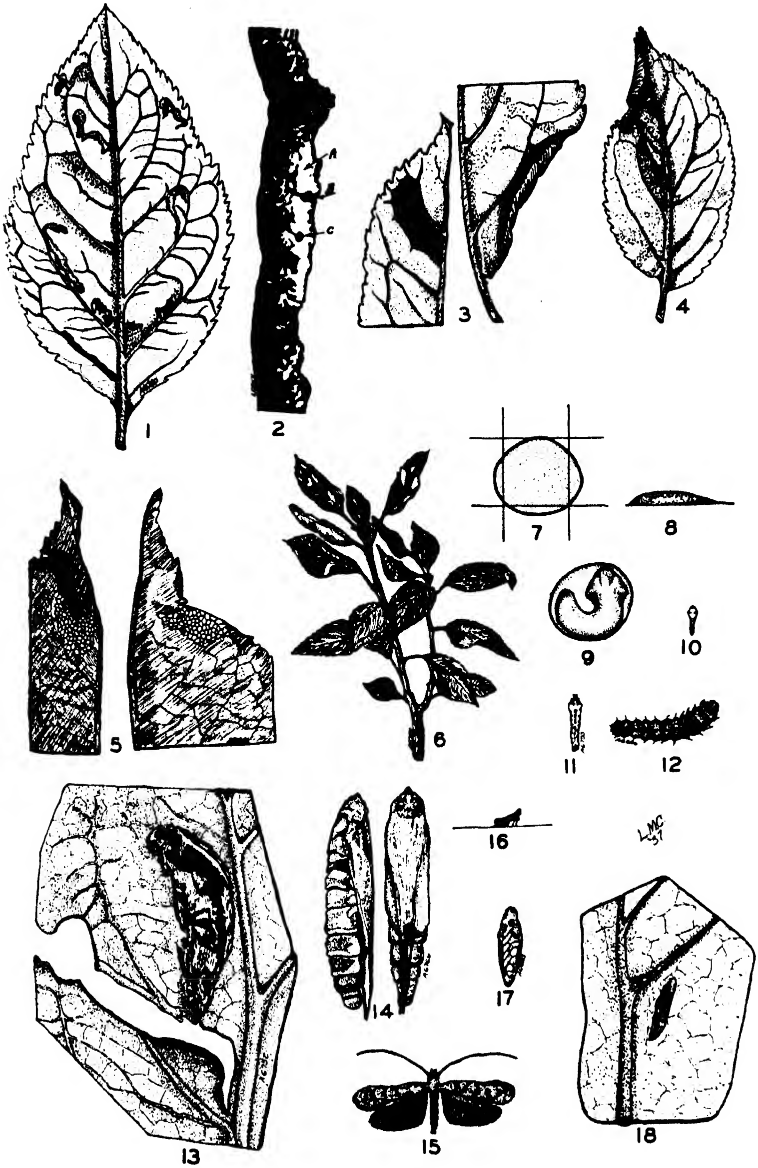

Plate II—Various Stages of Mines of **Ornix prunivorella** Chamb., and Life Stages of insect.

Plate II (Concl.)

8. Egg showing elevation and how it is firmly cemented around the edges to the leaf (binocular highpower) (diagrammatic drawing).

9. Embryo of insect inside of egg when almost ready to hatch (binocular highpower) (diagrammatic drawing).

10. First instar larvae, showing the likeness to a very small "flat headed borer" (diagrammatic drawing).

11. Larva, slightly shrunken, third moult (Drawn from photograph taken in July, 1933). 5x.

12. Larva, last moult stage (Drawn from photograph taken July 14, 1933). 4x.

13. Leaf unfolded to expose cocoon of insect (Drawn from photograph taken October 6, 1933). 3x.

14. Pupa, dorsal and ventral sides (Drawn from photograph taken October 19, 1933). 7x.

15. Adult Moth with wings expanded showing the feather-like hind wings. 3x.

16. Adult moth at rest and showing its characteristic position when resting or when the insect alights. 1x.

17. Hymenopterous external larval parasite (Drawn from photograph taken July 14, 1933). 4x.

18. Parasite in cocoon (Drawn from photograph taken July 14, 1933). 4x.

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THE SEVENTH ANNUAL INSECT POPULATION SUMMARY OF KANSAS. COVERING THE YEAR 1937*

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The only important change in the method of making the survey and preparing this seventh annual summary was that four pages of drawings with descriptive notes on the insects listed in the questionnaire were sent to the co-operators this year to reduce or eliminate errors which might result from mistakes in identifying the insects.[3]

Questionnaires returned and summarized:

Group I Entomologists in the state: In July—22 In October—18.

Group II County Agr. Agents: In July—89 In October—62.

Group III Farmers, mostly college graduates: In July—18 In October—22

Vocational Agr. Teachers, selected: In July—53 In October—40

Total reports ....July—182 October—142

Grand total of questionnaires summarized 324

In addition to these sources of information, the reports of Prof. H. R. Bryson to the Insect Pest Survey, the annual report and extra surveys of the Extension Entomologist, reports of survey trips through the state and a summary of the department correspondence have been consulted particularly for the "Insect notes" part of this summary.

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*Contribution No. 457 from the Department of Entomology.

**This report embodies results obtained from investigation on Project No. 6.

(1) Professor of Entomology and Associate Entomologist, Kansas Agricultural Experiment Station. Mr. Merle E. Dowd, an NYA employee, again assisted with this survey and summary.

(2) Extension Entomologist. Division of Extension.

(3) References to the previous surveys follow:

1931—Journal Kans. Ent. Soc. 5(3): 65-91. 1 pl. 1932
1932—Journal Kans. Ent. Soc. 6(2):37-59. 1 pl. 1933
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1934—Trans. Kans. Acad. of Sci. 38:171-185, 1935
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1936—Journal Kans. Ent. Soc. 10(4):113-132, 1937

Weather and Crop Conditions in Kansas for 1937[4]

January was the fifth coldest in 50 years with comparatively heavy fall of moisture and a lack of sunshine. The first six days were relatively warm, but an exceptionally heavy fall of sleet on the seventh and eighth covered the eastern and southern portions of the state. Beginning the middle of the month, much of the state was covered with a coat of ice which was made heavier by rain and snow on the thirtieth. Cold waves occurred on January 6, 14, 15, 20, 28, and 31.

February The sheet of ice lasted until about February 20 with more snowfall than usual. When melted, the ice supplied sufficient moisture to put the top soil in good condition and end the dust storms temporarily.

March was abnormally cold and cloudy so that the spring was backward and late. A fair amount of precipitation fell and moisture conditions favored the growth of wheat plants and reduced dust storms in number and severity except in the west. Spring planting was delayed.

April was the driest for 50 years. As a whole, the month was too cool and dry for good growth of vegetation. Since crops were planted two or more weeks later than usual, no material damage resulted from frosts.

May was warmer than usual and was deficient in rainfall over most of the state. The first cutting of alfalfa was generally small, but the season was favorable for wheat.

June had some good rains, but in most sections moisture was inadequate especially in northeastern and eastern central counties. It was a favorable month for wheat, oats, and corn, but the dry hot weather during the latter part of the month was unfavorable for alfalfa, pastures and gardens.

July was characterized by timely though generally inadequate rains with comparatively pleasant weather during most of the month. Threshing wheat and oats was difficult in southeastern counties because of wet weather. Over much of the state, hot weather occurred

4 Largely summarized from the monthly reports of S. D. Flora, U. S. Dept. of Agr. Weather Bureau, Climatological Data, Kansas Section, Vol. 51, Nos. 1-13, 1937.

between rains and became continuous at the close of the month. Pasture grasses and alfalfa deteriorated during the month.

August was the fourth hottest and the eleventh driest in 51 years. It was a severe month for crops, since corn and alfalfa were badly damaged.

September was exceptionally warm and dry over Kansas with about the usual amount of sunshine. Combined with August, the period was the driest two months since 1922. Pastures were in poor condition, corn ripened somewhat prematurely, and alfalfa was left in the poorest condition for many years.

October was deficient in rainfall except in the north-central and northwestern counties. Temperatures were abnormally high during the first five days and the closing week. This was the seventh successive month of deficient rainfall leaving the soil exceptionally dry. The combined rainfall of September and October was only half of the total for these months in 1936. The first killing frost occurred on the fourteenth in the northeastern counties and on the twenty-second and twenty-third elsewhere. By this date most crops had matured. Wheat had a late, unpromising start and considerable reseeding was necessary around the borders of fields because of grasshopper damage.

November was also characterized by deficient precipitation though heavy snowfall occurred in most eastern counties. Temperatures averaged much below normal because of a long severe cold spell the latter half of the month. Temperature and sunshine were near normal, however, in the western part of the state. Wheat in the eastern half of the state improved some because of moisture additions.

December was unusually cold and precipitation was generally deficient. All of the state except some southeastern counties had less than an inch of precipitation during the month. Snowfall was light except in the western portion where one to four inches fell. Heavy coatings of ice were formed on the thirteenth, fourteenth, and fifteenth which were sufficent to break many trees.

In general 1937 was another drought year, the seventh in a succession of sub-normal rainfall. However there were good crops of wheat and oats in all but the west central and western counties, while yields were re-

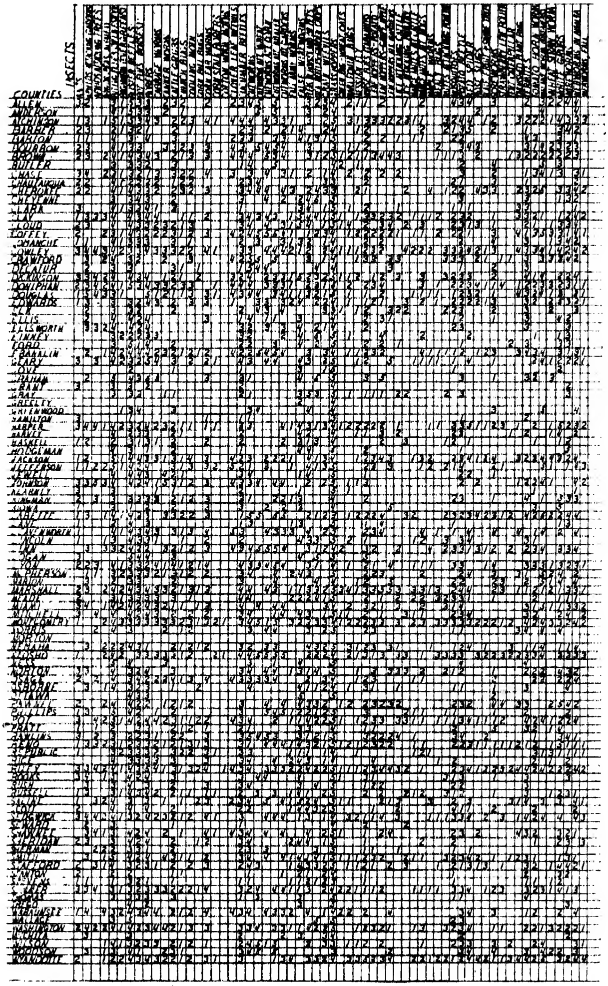
duced in southeastern counties by rust. A fair corn crop was harvested as far west as Saline County. Exceptionally good peach and apple crops and good crops of potatoes, melons, and tomatoes were secured Alfalfa generally produced only 2 or 3 light cuttings and pastures were poor during the year.

TABLE I - SUMMARY OF WEATHER DATA FOR THE STATE OF KANSAS FOR THE PERIOD
September 1, 1935 to December 31, 1937

Month	Temperature					Precipitation (in inches)					
	State Average	Maximum	Minimum	Average for 50 years	Departure from normal	State Average	Average for 50 years	Departure from normal	Eastern third	Middle third	Western third
Sept. '35	69.1°	102°	31°	69.5°	-0.4°	3.17	2.81	-0.36	4.18	3.04	2.29
Oct.	56.1°	91°	17°	57.0°	-0.9°	2.88	1.97	+0.91	4.96	2.22	0.58
Nov.	40.2°	75°	3°	43.3°	-3.1°	2.31	1.31	+1.00	3.86	2.07	0.99
Dec.	33.8°	65°	-3°	32.8°	+1.0°	0.27	0.85	-0.58	0.43	0.23	0.16
Jan. '36	26.3°	70°	-21°	29.8°	-3.5°	0.71	0.66	+0.05	1.13	0.66	0.34
Feb.	22.2°	84°	-23°	32.9°	-10.7°	0.23	1.00	-0.77	0.45	0.17	0.08
Mar.	48.5°	90°	9°	43.3°	+5.2°	0.14	1.42	-1.28	0.24	0.06	0.11
Apr.	54.5°	98°	-2°	54.7°	-0.2°	1.17	2.56	-1.39	1.69	1.01	0.81
May	67.7°	99°	36°	63.8°	+3.7°	4.88	3.80	+1.08	4.90	4.44	5.29
June	77.3°	114°	44°	73.8°	+3.5°	1.26	4.00	-2.74	1.30	1.42	1.07
July	85.7°	121°	50 °	79.0°	+6.7°	0.86	3.20	-2.34	0.83	0.83	0.93
Aug.	85.3°	119°	47°	77.6°	+7.0°	1.06	3.13	-2.07	0.92	0.95	1.32
Sept.	72.5°	107°	31°	69.6°	+2.9°	4.84	2.86	+1.98	7.38	4.93	2.21
Oct.	55.8°	92°	12°	56.9°	-1.7°	1.82	1.96	+0.15	2.44	2.07	0.94
Nov.	43.1°	80°	7°	43.3°	-0.2°	0.18	1.29	-1.11	0.49	0.04	0.02
Dec.	37.7°	69°	-1°	32.9°	+4.8°	0.86	1.16	+0.30	1.86	0.99	0.62
Averages or totals for 1936					+17.5°	18.01	27.04	-8.14	23.63	17.57	13.74
Jan. '37	21.3°	63°	-20°	29.6°	-8.3°	1.40	0.67	+ .73	2.33	1.47	0.39
Feb.	32.7°	75°	-11°	32.7°	0	.68	.99	- .31	.95	.71	.37
March	40.0°	77°	0	43.3°	-3.3°	1.65	1.42	+ .23	2.59	1.50	.86
April	54.3°	98°	15°	54.7 °	- .4°	1.00	2.53	-1.53	2.04	.57	.39
May	66.7°	102°	32°	63.8°	+2.9°	3.15	3.78	- .63	4.06	3.96	1.44
June	74.3°	109°	38°	73.8°	+ .5°	3.27	3.98	- .71	3.59	3.18	3.03
July	81.7°	113°	52°	79.0°	+2.7°	3.14	3.20	- .06	3.97	3.76	1.70
August	83.5°	113°	52°	77.7°	+5.8°	2.06	3.13	-1.07	2.43	2.17	1.57
Sept.	71.3°	106°	30°	69.6°	+1.7°	1.90	2.83	- .93	2.38	2.05	1.27
Oct.	57.2°	96°	18°	57.0°	+ .2°	1.43	1.95	- .52	1.49	1.59	1.22
Nov.	41.0°	87°	- 2°	43.2°	+2.2°	.67	1.27	- .60	1.26	.60	0.15
Dec.	31.8°	73°	- 8°	32.8°	-1.0°	.53	.85	- .32	.92	.38	.29
Aves. or Totals 1937					- .2°	20.88	26.54	-5.66	28.01	21.94	12.68

Since the table of weather data for 1936 was omitted in last year's summary, it is included here.

Plate I. Insect summary from questionnaires returned in July and October for all of the counties of the state except Morton.



The more striking insect activities and climatic relationships for 1937.

Ants (Formica sp.) were exceptionally plentiful during September and October and many specimens were sent in as possible termite invaders. The winged forms swarmed out of nests around porches, trees, stumps, cellar windows, and in basements.

The **yellow ant** was fully as abundant from March to June in basements of homes and on the outside of foundation walls as usual. This species appears to be on the increase.

The **mound building ant** made larger mounds and more of them during 1937 than in 1936 and were unusually active in alfalfa fields.

Apple curculios were scarce in northeast Kansas during the spring of 1937 according to Dr. R. L. Parker.

Aphids in general were not particularly plentiful during 1937. The **cabbage aphid** reached damaging numbers on cabbage in Riley and other eastern counties in May. **Spiraea aphids,** probably **(Aphis spiraecola** Patch), appeared on the new growth in early June in normal numbers. The **elm leaf aphid** again reached outbreak proportions the latter part of May in the eastern half of the state. Honey dew was dropped on cars parked under elm trees and muscoid flies were attracted to it. Cars with tops covered with bluebottle flies were seen between May 28 and June 21 when rains washed the honey dew from the elm foliage. Dust and cotton from cottonwood trees settled in the honey dew making the grass and shrubbery unsightly. The extension entomologist estimated that there were several thousand moths of **Plusia simplex,** the army worm and variegated cut worm moths around his car at Tonganoxie on June 17th while it was parked under an elm tree. A black fungus grew in the honey dew causing low vegetation and water in fish pools to become black. By the latter part of June, aphid enemies such as lady beetles, chrysopids and syrphid fly larvae were able to terminate the outbreak. Healthy elms did not develop the peculiar yellowish or salmon colored foliage which often presages their early death.

Pea aphids were not found in alfalfa fields until April 10. The cold, backward spring apparently delayed their advent. Alfalfa made little growth before mid-April. Pea aphids were particularly scarce during the

previous summer and fall so the season began with an abnormally low population.

By May 12, pea aphids occurred in small numbers in most alfalfa fields of the state but the new growth was then knee high and aphid predators were plentiful.

By May 19, pea aphids had built up to 20 cc. or more for 25 sweeps of a net in Riley county. There was also an extremely large population of syrphid larvae. They were more plentiful than lady beetles. Aphids reached a balance with other environmental conditions near alfalfa blooming time and no reports of injury were received.

By June 6, pea aphids were scarce in the fields. Only occasional adults could be found on alfalfa and vetch. Peas were dusted by the Columbus Foods Co. at Lawrence where damage to peas occurred. The small population of aphids decreased rapidly from June 10 to July 20 when only occasional ones could be found. However no pea aphids could be found in the state after July. They were completely absent during the fall.

Alfalfa stands were at a low point in the state for 1937. There were few young stands, most stands being 3 or more years old and they were thin and grassy.

The **rusty plum aphid** began to appear in considerable numbers on plum and peach trees in Riley county about May 18 but they were soon decimated by predators. They were abundant in the fall on grasses of the genus **Eragrostis** according to Prof. D. A. Wilbur.

Radish aphids were more abundant than usual during May in Riley county.

Some **greenbugs (Toxoptera)** were reported in early spring on wheat and oats, but they confined their damage to near Enid, Okla. No injury was seen or reported.

The **corn root louse** was reported abundant near Topeka in May.

Army worms occurred in a wide spread outbreak in southern and eastern Kansas during June. They were first reported along the Oklahoma border. As usual, these larvae were most plentiful in grassy plots, grass land, wheat and garden crops. The use of bran mash for control was hampered by rain. About 30 percent of the larvae were parasitized. A large population of moths occurred at lights during July. The high summary num-

bers in southeastern Kansas counties for cutworms attacking wheat, corn and alfalfa reflect primarily the large population of army worms in that region.

Wheat head army worms also called "barber worms" attained damaging numbers in early June in the eastern half of the state. This and army worms ate the beards and glumes off heads of wheat and rye particularly in Elk, Montgomery, Wilson and neighboring counties. It was reported that these larvae also climbed fruit trees and ate foliage.

Fall army worms occurred widely in the state but many population numbers reported for this species were too high in the opinion of the authors These were reduced because it is believed there was some confusion as to the species seen. No important damage was seen by the authors nor was any reported.

Blister beetles first appeared in alfalfa fields about the middle of May. Small gray species became exceptionally plentiful by early June and damaged alfalfa blossoms by eating the petals. By mid-June, damage to foliage of apple seedlings in the Kaw valley was reported. They reached damaging numbers in gardens by the last of July. There was a succession of species with more than ordinary numbers until early October. The outbreak, while wide-spread, was not severe. The large population reflects the large number of grasshopper eggs upon which the larvae feed and the favorable effects of the dry weather.

Box elder bugs began reaching the adult stage in Riley county on June 24. Many eggs were deposited on the bark and flowers of maples. The young nymphs fed on the seeds and clustered on the trees for the first time in nearly 5 years. The numbers indicated a return to a normal population after reaching nearly zero in 1934 and 1935. They went into hibernation around homes in Manhattan in sufficient numbers during October to cause annoyance.

Bees wintered well where stores were sufficient. The weather was too cold and wet in early April to allow normal flight during the blooming of maple, elm, and willow. However they had good flying weather during the fruit blooming time. A shortage of sweet clover due to the drought caused some beekeepers to quit and others to move from the state. Bees were not

maintaining weight until they began collecting nectar the last of July from Spanish needle in southeastern Kansas and smartweed in the eastern half of the state. American foul brood was prevalent during the dry, hot summer. Some beekeepers reported a fair yield of honey from bloom in late summer.

Borers especially the flat headed apple tree borers continued about as prevalent as last year judging by correspondence and observations on trees. They are attacking practically all kinds of trees and many shrubs such as spiraea.

Professor G. A. Dean reported several adults of the 4 spotted **hickory borer (Eburia quadrigemminata)** emerging during the year from oak floors in houses and an instance of one emerging from an oak desk several years old.

Cabbage looper (Autographa sp.) moths were exceptionally plentiful in May and June at flowers in the evening and at honey dew. Several species occurred but the larvae of these moths were not particularly common on alfalfa, cabbage and wild lettuce.

Cabbage curculio adults did serious injury to cabbage during June. They gathered around the margin of the leaves and punctured them causing the edges to turn brown and wrinkled.

They damaged or destroyed sweet Alyssum in Riley and Saline counties the last of June according to Prof. G. A. Dean.

Cankerworms were scarce over almost all of the state during the spring of 1937. Many trees were banded in Riley county and elsewhere but only an occasional canker worm moth was caught on the bands. The population of this insect is at the lowest point for 10 to 15 years.

However, a few elms during May showed some cankerworm injury to leaves near the trunks of trees. Larvae were about half grown by May 20. It was reported that some elm trees at Westmoreland and south of Manhattan were entirely stripped by cankerworms.

Carrot beetles (Ligyrus gibbosus) was unusually plentiful at lights all year. Injury to root crops, zinnias, marigolds and other flowers was reported from Spearville.

Cattle grubs probably declined somewhat in population in the state during 1937 largely because of the decrease in the number of cattle in western Kansas. There are now few cattle from Ellis county west to the Colorado border. There are fewer cattle infested and the average infestation is lighter than in 1936.

Chinch bugs were the scarcest in years. There probably was not a mile of barrier built in the state in 1937. The bugs did not survive the severe winter in their inadequate hibernating quarters. While weather was favorable for them, they failed to build up until late summer. Timely rains probably destroyed the greater part of the bugs of both generations in their early stages according to W. T. Emery. There was only a small population in hibernation during the close of the year. The summary numbers indicate a most unusual picture for the state, though some injury was reported at Parsons.

Chrysopid adults, especially **C. plorabunda, C. oculata,** and **C. rufilabris** were exceptionally plentiful during the summer and early fall of 1937. They came to porch and street lights by thousands. Never have the writers seen them so plentiful. The larvae did not appear to be abnormally plentiful in gardens and alfalfa fields. It is believed these insects assisted materially in reducing chinch bugs and aphids during the growing season.

Some **17 year Cicadas** were heard in the region from Independence, Kansas north to Lawrence early in July. While the great majority of the cicadas singing in the wooded draws were the common one or two year species, the songs of some periodical cicadas were recognized. No adults were taken, however.

Clover leaf weevils were more numerous than last year and reached about normal numbers in alfalfa fields during the spring. They were plentiful in Riley county and some damage was reported from Leavenworth county the middle of May. Injury chiefly by adults sufficient to retard the second growth in early June was reported at Tonganoxie.

Corn bill bugs were not plentiful and caused no serious damage in 1937. They were present in areas 1, 2, 5, and 6b.

Crambids or sod webworms and moths were excep-

tionally plentiful in grass lawns and around lights in September and early October. Lawns were damaged at Atchison. The source of the exceptional numbers observed was not known.

Black Crickets were more destructive and numerous in homes, in Kansas during 1937 than for many years. By early August, the common black cricket was a great annoyance practically all over the state. The hot dry weather drove them to basements. They continued to be annoying until about October 1st. Hedgeballs were recommended by some communities as valuable repellents against them, but no evidence of their effectiveness is at hand.

Colorado potato beetles were scarcer than usual during the spring. The first generation which was abnormally light completed its development the last of May.

Corn ear worms were present in usual numbers or more thoughout the season. Practically all ears of field corn showed some injury by them. They caused less than usual injury to the curl of corn and some injury to the fruit of tomatoes in eastern Kansas. The population in alfalfa fields during the late summer and early fall was less than normal. During the fall, they attacked sorghum heads. They were more numerous throughout eastern Kansas than for several years.

Cutworms varied in population during 1937, some species being scarce and others occurred in outbreaks. The **army** cutworm was numerous only in the western part of the state in pastures according to Mr. H. H. Walkden, but no damage to cultivated crops was seen or reported. The **dingy** cutworm was the most plentiful early species but the population of this species was low compared with previous years. It occurred in largest numbers in grass plots, pastures, alfalfa fields and under trash. They developed slowly because of the cold late spring and matured somewhat later than usual.

The **pale western cutworm** occurred in the most destructive outbreak ever recorded in Kansas in several western counties in 1937. They became fully grown about the middle of May and aestivated. They were found in a stubble field of a section of land in Rawlins county on May 7. A survey by Mr. H. H. Walkden showed them to be numerous in Ellis, Rush and Meade counties. Summary numbers of cutworms attacking

wheat in Rawlins, Decatur, and Thomas counties refer also to the pale western cutworm. This species did not occur on summer-fallowed land which indicates a method of control for future years.

There was a definite widespread outbreak of **variegated cutworms** during early June in alfalfa fields and garden in eastern and southern counties of Kansas beginning early in June and extending as far west as Osborne county. A few larvae of this species were received May 18 from southern Kansas which was the time that the outbreak of army worms was developing. The damage was severe in many communities. Growth of alfalfa following the first cutting was prevented. Reports of as many as 30 larvae to the square foot were received. The larvae were mostly grown by June 10. Rains in the infested areas interfered with bran mash sowings. Some cutworm damage to alfalfa fields in the Kaw Valley was observed in mid-July.

Cutworm moths began appearing at lights about May 20. They were found in large numbers by the middle of June, and continued plentiful to the last of July, the variegated reaching a peak the last of June and in early July. **Autographa** and **Caenurgia** moths made up the majority of them. Hordes of moths were reported during this period from Arnold and Tonganoxie, Kansas. The moths clustered on orchard grass infested with leaf hopper nymphs and on aphid infested elms for the honey dew deposited there by these insects.

During the last of July, **cotton cutworms** became plentiful. Some injury to tomatoes and sweet corn by this species was observed.

Clover root curculios (Sitones hispidula) were more plentiful in the state than for possibly five years. This species practically disappeared after a peak population about 1929, but it is building back to normal numbers. There were almost normal numbers in Riley county in 1937. Damaging numbers of adults and larvae were seen and reported in Wabaunsee county early in June.

The **diamond backed moth (Plutella maculipennis)** occurred in large numbers in all northern counties from Marshall to Phillips counties during May, being a feature of the spring of 1937. The larvae fed on pepper grass or "bird seed grass" and pupated on such nearby plants, as alfalfa and wheat but did not feed upon these plants.

The moths were common at lights from the middle of May through June.

Eight spotted forester moths attained in the late spring the largest population seen in the state for several years. The moths occurred especially at flowers while the larvae caused injury to Virginia creeper and both wild and cultivated grape foliage. Injury by this species was reported from Riley and Doniphan counties.

False chinch Bugs (Nysius ericae) were numerous in September on purslane in Riley and perhaps other counties.

Flea beetles were conspicuously absent in gardens during the spring. No injury from them was seen nor reported.

A statewide outbreak of **biting flies** on livestock occurred in Kansas during early August. following the July rains. They bred in the trash accumulated by high water along creeks. Some dairies at Independence dropped 50 percent in milk production. Farmer's deductions from seeing dead flies in bait mixing plants resulted in a serious newspaper blunder of recommending spraying cattle with sodium arsenite to kill attacking flies. Such sprays caused the death of some animals and serious injury to others. The outbreak of flies was over by September 1.

There was a slightly less severe outbreak of biting flies in the Kaw valley during the last of May. Riley county cattle were heavily attacked. By the first of June, many letters asking for repellent spray formulae had been received and dealers reported being sold out of pyrethrum extract.

Screw worm flies were fairly active again during 1937 and were reported attacking cattle, hogs, and other animals in 22 counties. Pasture cattle and new born calves were attacked most severely in the following counties and after the name is given an estimate of the number of farms reporting these pests: Barber, 375 farms; Butler, 350 farms both largely in cattle from Texas: Ellis, 150; Comanche, 60; Greenwood, Leavenworth, Elk and Pawnee, 50 each; Pottawatomie, 25; Woodson, 24; and Ottawa, 15. These pests also occurred in Jefferson, Osage, Chase, Cowley, Labette, Pratt, Rice and Riley counties. A total of 2641 animals were treated in the state for screw worms with no animals lost.

Blue bottle flies and closely related forms swarmed on May 20, in northern counties feeding on honey dew dropping from elms. It was thought that the large population of flies may have developed on dead grasshoppers last fall.

Encephalitis which is presumably a **mosquito** borne disease attacking horses, occurred in the largest outbreak in Kansas since 1912 throughout September to near the middle of October. State authorities estimated that between 4000 and 5000 cases occurred during this period about 50 percent of which terminated fatally.

Forage loopers (Caenurgia erechtea) was somewhat more plentiful than last year though the population of larvae in alfalfa fields in eastern Kansas was graded as average. Moths came to lights in greater numbers than usual during the summer and the larvae were more plentiful in September and October than for several years.

Grasshoppers occurred in a severe statewide outbreak again in 1937 though in general it was stated that the grasshopper population was slightly smaller than in 1936. The grasshopper population for 1937 was close to that predicted from fall surveys. Hatching began on May 10 in Riley, but it occurred earlier in southern Kansas. Comanche county was about two weeks more advanced than Riley county. The first adult migratory hopper was seen on May 31. The infestation in early June appeared spotted, being heavy in some places and light at others. By June 11, the hoppers were 1/3 to 1/2 grown. No fungus disease was found any place in the state. By June 14, hopper dozers were being used and extensive bait sowing campaigns were under way. About half of the migratory hoppers were then adult, and a second large generation of eggs was deposited. Poison bait sowings gave good kills even when sown for cutworms. The second generation of migratory hoppers began to appear about June 20, though some of the early small ones were probably from overwintered eggs.

The injury in eastern Kansas to sweet clover was marked. Most clumps were defoliated or barked. Alfalfa was the next most severely injured plant and corn next. The population appeared to be fairly uniformly distributed over the state but it was somewhat smaller in southeastern Kansas during the last of June. In Rooks county, grasshoppers destroyed the second growth of

wheat or late germinating wheat leaving the dry matured stalks to be cut or harvested.

There was a heavy parasitism of 20-30 percent by Sarcophagid flies during the summer. Horse hair worms (Mermis) were more plentiful than for years, the infestation being as high as 35 percent while mites on the wings occurred on 20-40 percent of the hoppers.

During early August, most of the second generation nymphs were out and throughout most of the state, alfalfa was more severely damaged than corn. Reports of flights were regarded as fictitious. There was more vegetation, especially weeds, than during 1936 which served to help keep them out of crops and furnished sufficient food for maturing a large healthy population.

Epsom salts were recommended in newspaper articles as an adequate substitute for arsenic and were widely used for making baits with unsatisfactory results. Tests showed that the material was without value for the purpose.

Late summer damage centered especially on corn. In some sections, corn was practically destroyed. In Riley county 10-60 percent foliage damage was common but a fair crop of grain was produced.

The weather from September to early November was most favorable to maturing nymphs and egg deposition. The 1937 fall deposition of grasshopper eggs was the largest ever found in the history of the state. Many grass clumps had as many as 10 or more capsules in them. Egg deposition continued until the abnormally severe cold spell beginning on November 14, killed the adults. The smaller species lived longer than the larger ones or differential and two-lined. The appearance of small nymphs in late October suggested the possibility of a partial third generation of **Chortophaga viridifasciata.** Fungus or other diseases never appeared during the season but parasites, hair worms, flies, mites and blister beetles continued to be more plentiful than usual throughout the fall.

A feature of the year was the marked eastward spread of the southwestern **lubber grasshopper.** For the first time in years it was fairly common in Riley and Wabaunsee counties. It fed on sunflowers and coarse weeds along creeks, roads and shaded areas.

The following quantitative information from the 1937 outbreak is given for further insight into the grasshopper population and damage for the season: 103 counties carried on grasshopper control; 611 hopper dozers were built in 78 counties and were used to treat 9,294 acres of grassland in 29 counties and 19,391 acres of alfalfa in 72 counties. The Federal government supplied 104,813 gallons of sodium arsenite while the total used from all sources was 139,242 gals. There were 3,-273,000 lbs. of "mill run" and 7,122,166 lbs. of sawdust used in making a total of 26,822,480 lbs. of wet bait which was used by 75,246 farmers. Kansas farmers spent $77,151 on bait and the government $85,000. A total of 3,352,606 acres were treated one or more times with poisoned bait of which 1,186,060 acres were in wheat, 875,942 acres were in corn, 230,980 acres in alfalfa and other legumes and 346,845 in grassland. Bait was used in 43,631 gardens or 32,868 acres and 876 orchards of 8,315 acres.

The damage done may be summarized as follows:

Number acres wheat slightly damaged **2,183,186;**
destroyed .... 104,925 Acres

Number acres oats slightly damaged **285,900;**
destroyed .... 15,870 Acres

Number acres barley slightly damaged **101,245;**
destroyed .... 55,075 Acres

Number acres corn slightly damaged **776,400;**
destroyed .... 163,992 Acres

Number acres alfalfa slightly damaged **277,349;**
destroyed .... 64,027 Acres

Number gardens damaged 58,161

Number orchards damaged 3,889

Grain weevils apparently increased in population in 1937 over either 1935 and 1936. Dr. R. T. Cotton reported that "Inspection records of grain arriving on the Kansas City market during the period of July to December indicated an increase in weevil infestation. During the preceding season less than 1 percent of cars of wheat arrived on the Kansas City market graded weevily whereas in October and November of this year nearly 4 percent were graded weevily."

Green Clover worms were slightly more plentiful than normal. There is, however, generally a large population which often does noticeable injury.

Hessian fly over all the state had in 1937 the smallest population in years. This insect did not materially affect the yield of wheat anywhere in the state.

Fall wheat was sown generally without regard to the safe seeding date. Some sections sowed in August. The fall was dry and wheat was slow in coming up. The fall survey showed a maximum population of about 13 percent of stems infested in all but northwestern Kansas which had none. Examinations in central Kansas on October 26 showed that many wheat stalks which had come up early were infested with fly while stalks which came up just after the October showers were not infested. The year closed with Hessian fly building up in numbers due to late egg deposition. The summary map presents a most unusual picture for the state.

Imbricated snout beetle was reported damaging melons in Johnson county during May. Grass was injured by this species and another snout beetle (Sphenophorous) in Riley county according to observations of Prof. D. A. Wilbur.

Leaf hoppers of three or four species came in great numbers to lights during September and October and caused damage on apples (especially in Doniphan county), some shade trees, grapes, woodbine, and some garden plants. By early October, serious damage occurred on apple and woodbine in the eastern part of the state. Leaf hoppers continued abnormally plentiful until late October. They occurred in great numbers on elm. oak, and sycamore in Riley and neighboring counties.

Both **chewing** and **sucking lice** on domestic animals were somewhat less numerous and destructive than during the last two or three years. There were few reports of infestations received during the spring.

Mites (Petrobia tritici Ewing) were reported in destructive numbers in wheat fields near Salina on April 19. Infested fields or spots in wheat fields appeared yellow as if suffering from lack of moisture. An examination revealed all stages of the mites present. The mites at the same time occurred in destructive numbers in Oklahoma and Texas. The hot dry period during the last of March and for three weeks in April favored their increase. This

species of mite also occurred from Clark and Meade counties west to Liberal and the mite with the dry weather destroyed considerable wheat. It did damage in Meade, Stanton, Morton and Stevens counties and helped reduce wheat fields of some 500 acres virtually to a desert and was referred to as the "dust bowl" mite. The green wheat turned reddish resembling cured hay. The plants lie flat and the color is characteristic of the injury.

The **clover mite** occurred in small numbers in southwest Kansas in April. The common **red spider** occurred on columbines, beans, and evergreens, but not in great numbers. This species did less damage to evergreens than would be expected in a hot dry year.

Some other mites were also more plentiful than usual during 1937. **Eutrombidium locustarum,** the grasshopper mite was exceptionally plentiful all over the state. Overwintering adult mites were seen in Dickinson, Brown, Jackson, Phillips and Ellis counties feeding on grasshopper eggs in March. Later these mites were found in all the eastern counties crawling over the ground and their presence was used as an indicator of the location of grasshopper eggs. The mites deposited their eggs near grasshopper egg beds.

Mites were exceptionally numerous on grasshopper wings all season. They were the subject of considerable newspaper publicity in the state overemphasizing their importance. The nymphs left the grasshoppers in August and early September and adults were seen crawling on the ground going into hibernation.

Mites (red spiders) were bad on elm foliage during the latter part of the summer especially in the central and much of the eastern half of the state. Injury was done by red spiders to beans, flowers, shrubs, and vines from June to September.

Monarch butterflies were first seen in eastern Kansas June 15 and in Riley county on June 21. The wings were frayed.

Negro bugs were observed in large numbers in Riley county on annual violet in early May. This was the third successive year that this species was plentiful. They caused injury to snapdragons, daisies and coreopsis plants at Manhattan.

The **onion plant bug (Labopidea allii** Knight) which was reported for the first time in Kansas in the summary

for 1936, assumed outbreak proportions in Riley county and the Kaw valley during May. The adults and nymphs clustered on onion stalks causing the tips of the stalks to turn brown and many leaves to die. The bugs are active, therefore difficult to control by spraying. Outbreaks on onions were reported from many places around Manhattan, also in Mitchell, Marshall, and Doniphan counties. By June 5, the bugs had largely disappeared. The injury to onions was somewhat overcome by timely rains though many patches of onions were killed. Nothing controlled the bugs successfully.

The **red bud leaf folder** was exceedingly abundant in Riley county all season. It built up to outbreak numbers in all eastern Kansas counties and the third generation folded practically every leaf on red bud trees. The population was as high as in 1934.

Scale insects were reported plentiful in Manhattan on old cedar trees by Mr. R. G. Yapp.

Evergreens on the college campus in Riley county were heavily infested with a scale insect (**Cryptaspidiotus shastae** Coleman) which in early September was highly parasitized by a small chalcid (probably a Trichogramma). The scale is favored by dry, hot conditions.

The **rose slug** was less abundant than for several years. Some injury to rose foliage however occurred in May and June. It was reported from Montgomery, Jewell, Riley, Brown, and Doniphan counties.

Seed corn maggots were more plentiful and destructive than usual during April and May of 1937. Reports of injury to corn, kafir, melons, and beans were received in May. Anderson, Phillips, Jewell, Riley, and Franklin counties reported injury. Replanting of corn was necessary in some fields. Seed germinated slowly due to wet, cool weather. These are the conditions which favor this pest.

Sphinx drupiferarum (A & S), the wild cherry sphinx, a medium sized black and white sphingid moth was exceptionally plentiful in Riley county. The species was not in the college collection before, but practically all sphingids in student collections during May were of this species. It is perhaps a western species which has come in as a result of the drought. The moths were still plentiful at lights at mid-June and at flowers in the evening.

The **strawberry leafroller** was less abundant in Doniphan county during the spring than for the past two years according to Dr. R. L. Parker. However, the species was abundant and destructive in several counties as shown in the summary table.

Squash bugs were again plentiful from June to October. They were more destructive to pumpkins and squashes than for several years. The dry hot summer weather favored them.

Tarnished plant bugs reached outbreak proportions in the fall when damage was done to late potatoes, nursery stock, alfalfa, gardens and some flowers, especially Chrysanthemums. These insects appeared early. The first generation ended about May 19 in Riley county. The second generation appeared about the last of June and the third from September on. The fall population was the largest for several years in Wyandotte, Johnson, Douglas, and Riley counties. Serious damage was done to late potato foliage in a few fields. Tarnished plant bugs went to alfalfa fields for overwintering in early October in large numbers.

The **walnut datana** defoliated walnut trees more or less completely in July and August in eastern and southeastern Kansas. The outbreak was particularly severe around Independence. The population was no more than normal in central Kansas. The **sumac datana** defoliated sumac in Riley county in September.

Termites were late in swarming because of the cool, wet, late spring. Up to April 10, only two swarmings were observed at Manhattan. Activity in buildings was reported to the usual extent from early March. They swarmed again in Riley county on May 12, and 17. They were plentiful under boards and in stumps on May 19, but soon disappeared from these places. One small swarm was seen October 17, following 1.75 inches of rain.

The **unspotted tentiform leaf miner (Ornix prunivorella** Chambers) was abundant and destructive in Doniphan county all season according to Dr. R. L. Parker. It was first found there in 1934, and in the college orchard 1931-32 (but identified 1933). This species is favored by drought and increases during the season reaching largest numbers in the fall.

Garden web worms first appeared in outbreak num-

bers on small corn in Riley and Dickinson counties. This early damage in June was done by the first generation. The moths of this species were plentiful at lights during the summer but the larvae did not reach damaging numbers until the third generation the latter part of August, when damage occurred to young alfalfa from Sedgwick county east. This species was plentiful during August at many points in the western half of the state but cutting infested alfalfa promptly appears to have handled the situation. Some harrowing of fields was also done to destroy the pupae. Larvae and moths persisted in Riley county until the last of September.

False wire worms were plentiful during the fall and winter of 1936 but little damage was done. They continued plentiful in the spring of 1937 and built up to damaging numbers due to favorable weather in 29 counties in areas 6a, 6b, 7, 9, and 10b. Severe losses from this insect resulted in southwestern Kansas. Where wheat was sowed in dry ground over 1,000,000 acres were reported destroyed. Elsewhere the stands were left thin. False wireworms occurred as far east as Riley county, and damage was reported in Saline county. No large population nor serious injury was observed east of Clay county though adults of several species were common farther east. This species damaged watermelons in Barton county in June.

The **wheat saw fly** occurred more plentifully in wheat during early April than was ever known. It was found from Riley west and south of Ellsworth and McPherson counties. No perceptible damage was done to wheat. The larvae were heavily parasitized. They had largely pupated by June 10.

The **wheat straw worm** was scarce in all parts of the state.

Thrips were common during April and May on alfalfa and wheat. They reached about normal numbers during June on alfalfa and flowers in general.

Wasps (Polistes) were exceptionally plentiful in Riley county during October.

White grubs were moderately abundant in Kansas during the spring of 1937 and plentiful during the fall in areas 6b, 9, and 10c.

Wheat white grubs (Phyllophaga lanceolata) appeared in damaging numbers during June in Riley and

Harper counties on golf courses and grassland. The adults were heavily parasitized by a Sarcophagid fly according to Prof. H. R. Bryson. During the fall this species occurred in severe outbreak in about eight southcentral counties and somewhat less in 4 others. It is estimated that 400,000 acres of wheat were damaged or destroyed in the fall of 1937. This area included Harper, Barber, Comanche, Edwards, Kiowa, Pratt, Kingman, Sumner, Harvey, Marion, McPherson, and Reno counties. There was damage as far north as Riley, and Clay counties. Some fields were reseeded as often as three times and still failed to get a stand. The larvae ate off the roots and the plants quickly withered. The wheat white grub does damage in the odd numbered years because it has a two year life cycle. The heavily infested area extends into Oklahoma. The dry weather has extended northward the range of this pest.

Wireworms reached damaging numbers in southeast Kansas during the spring. Wheat was damaged at Wichita. The unfavorable soil conditions which retarded germination of seed favored damage. Corn and wheat were reported damaged in Wyandotte and Cherokee counties.

SUMMARY AND CONCLUSIONS

In general, 1937 was a record breaking drought year with an abnormally hot summer and winter months below normal temperature. The year's rainfall was deficient everywhere except in a few counties in southeast Kansas. Each of the last nine months was drier than usual. It was a year of more than usual insect populations and insect damage.

The following insects occurred in **outbreak** during 1937: elm leaf aphid, army worms, blister beetles, borers, cabbage curculio, black crickets, pale western cutworm, variegated cutworm, biting flies, grasshoppers, leaf hoppers, onion plant bug, red bud leaf folder, tarnished plant bug, walnut datana, garden web worm, false wireworm, and wheat white grub.

The following insects in addition to those mentioned in outbreak were **more plentiful** during 1937 than during 1936: formica ant, pea aphid, cabbage aphid, rusty plum aphid, radish aphid, wheat head army worm, fall army worm, box elder bug, cabbage looper, and curculio, carrot beetle, clover leaf weevil, cotton cutworm, dingy

cutworm, clover root curculio, crambid moths, diamond back moth, eight spotted forester, forage looper, grain weevils, corn ear worm, false chinch bug, green clover worm, imbricated snout beetle, screw worm flies, mites on wheat, clover and grasshoppers, negro bugs, red spider mites, onion plant bug, seed corn maggots, wild cherry sphinx, squash bug, tentiform leaf miner, wheat sawfly, white grubs, and wireworms.

The following insects were **scarce** or **nearly absent** during 1937; apple curculio, cankerworm, chinch bug, Colorado potato beetle, army cutworm, flea beetles, Hessian fly, and rose slug.

The following insects in addition to those mentioned as scarce were **less plentiful** than in 1936: cattle grubs, corn bill bugs, chinch bugs, rose slugs, and strawberry leafroller.

The following insects had **about the same population** as in 1936: yellow ants, mound building prairie ant, borers, corn ear worms, army cutworms, feltia cutworms, grasshoppers, termites, thrips, and scale insects.

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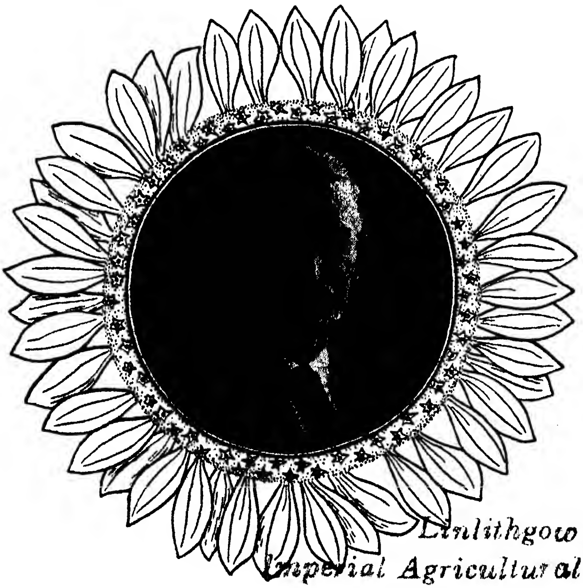

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1858-1937.

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Kansas Entomological Society

Vol. 11, No. 3. July, 1938.

SOME NEW SPECIES OF LEAFHOPPERS (HOMOPTERA-CICADELLIDAE)

R. H. BEAMER, Lawrence, Kansas *

1. **Laevicephalus hyalinus** n. sp., Fig. 1.

Resembling **Laevicephalus labeculus** DeL. but head sharper, median process of posterior margin of last ventral segment of female shorter, apices of male plates truncate and aedeagus with 45 degree bend near outer fourth. Length 3 mm.

Head considerably wider than body; vertex about as long as width between eyes, about a right angle, fairly rounding with front, disc flat, often quite concave; elytra longer than abdomen in both sexes.

Color: General color milky white to semihyaline. Vertex with frontal dark arcs visible and two longitudinal chain marks with openings in chain almost closed; some specimens hyaline throughout, others with more or less dark markings bordering veins.

Genitalia: Female last ventral segment twice as long as preceding, lateral margins broadly rounded to notch either side of a sharp median tooth. Male valve longer than preceding segment, broadly angular; plates broader than valve at base, outer margins evenly narrowed to sharply truncate apices, style heavy, slightly constricted just above apex to become avicephaliform; aedeagus in lateral view long and tapering, bent at right angles near basal fourth and again bent out at about 45 degree on outer fourth, apex with a pair of retrorse lateral processes about as long as length of shaft from last bend of apex.

Holotype male, allotype female, and numerous paratypes, Creede, Colo., July 6, 1937, R. H. Beamer, and Paposa Springs, Colo., 1937.

* Contribution from Department of Entomology, University of Kansas.
All types of new species in the Snow Collection.
Illustrations by Miss Maxine Graham.

2. **Laevicephalus hamatus** n. sp. Fig. 2.

Resembling **Laevicephalus hyalinus** n. sp. but smaller, head much more acute, disc of vertex slightly convex and male aedeagus with sagittate apex instead of with two retrorse processes. Length 2.5 mm.

Head wider than thorax, vertex acute, median length distinctly longer than width between eyes, disc usually slightly convex. Elytra longer than abdomen.

General ground color semihyaline to whitish with fumose markings. Vertex with pair of smoky longitudinal stripes, pointed at apex and with short white dash inclusion at base. Veins more or less infuscated.

Genitalia: Last ventral segment of female at the middle more than twice as long as preceding, at margins about the same length, posterior margin thus evenly produced at middle about its own length. Valve of male rounded; plates long, outer margins almost straight converging to sharp apices; styles sharply narrowed on outer third, curving sharply outward; aedeagus in dorsoventral view long, sides slightly converging to sagittate apex, with pair of very blunt processes or teeth before tip.

Holotype male, allotype female and 11 female paratypes, George West, Texas, July 4, 1936, R. H. Beamer.

3. **Hebecephalus pagosus** n. sp. Fig 3.

Resembling **Hebecephalus cruciatus** O. & B., but slightly larger, posterior margins of last ventral segment of female slightly produced instead of excavated and aedeagus of male much longer and more slender with slightly sagittate apex. Length 2.75-3 mm.

Head wider than pronotum; vertex sharp, about a right angle; elytra as long as abdomen in female, longer in male.

General ground color cinereous, strongly marked with fuscous. Vertex with frontal arcs visible on lateral margins, disc with three sets of fuscous spots, a pair of small triangles at apex, a dark pair of L marks near middle and 2 pairs of converging dashes at base. Pronotum with three pairs of more or less definite longitudinal dashes with heavier irregular marks along anterior margin. Veins of elytra evenly bordered with fuscous.

Genitalia: Last ventral segment of female about twice as long as preceding, lateral margins round, slight-

ly exposing underlying membrane, posterior margin slightly produced throughout middle two-thirds. Male valve obtusely rounding, plates long, slightly sinuate on outer margin, narrowed to bluntly angular apices, inner margins longest; styles narrowed on outer third, curved out; aedeagus long and narrow with slightly sagittate apex.

Holotype male, Pagosa Springs, Colo., July 5, 1937, R. H. Beamer. Allotype female and five paratype females, Mishawauka, Colo., August 11, 1937, R. H. Beamer; two paratype females same date and place, C. L. Johnston.

4. **Hebecephalus accuratus** n. sp. Fig. 4.

Resembling **Hebecephalus merus** Beamer, but posterior margin of last ventral segment almost straight, slightly excavated if anything and male plates with apices rounded and apices of styles not avicephaliform. Length 2.5-3 mm.

Vertex quite pointed, disc slightly convex, one-sixth longer at middle than width between eyes; elytra about as long as abdomen in male, shorter in female.

General ground color cinereous, marked with fuscous. Vertex with dark parallel chain markings enclosing a sagittate light area at apex and with a light dash in base of each chain. Veins of elytra quite regularly margined with fuscous, some of cells quite dark.

Genitalia: Last ventral segment of female slightly longer than preceding; lateral margins rounded at outer corner; posterior margin practically straight, very slightly excavated with very dark rectangular spot at middle. Male valve about twice as long as preceding, obtusely angular; plates about as wide as valve at base, narrowed to blunt apices about half width of base; styles widest at middle, one-third narrower on outer third, apex angular; aedeagus in lateral view with short, broad shaft with two pairs of retrorse processes, one pair at apex on side, the other ventral and just before apex, more than half as long as shaft and of about equal length.

Holotype male, allotype female, one male and 11 female paratypes, Silver City, New Mexico, August 22, 1936, R. H. Beamer.

5. **Hebecephalus acutus** n. sp. Fig. 5.

Resembling **Hebecephalus cruciatus** Osb. & Ball. but more robust; posterior margin of last ventral segment of

female practically straight across with but a small notch either side of a broad truncate median portion, pygofer hook of male large and blunt and apex of aedeagus rather rectangular in dorso-ventral view, with margins serrate. Length 3 mm.

Head wider than thorax; vertex angular, slightly longer than width between eyes, disc slightly concave; elytra longer than abdomen.

General ground color cinereous; vertex with three pairs of dark marks, a pair of small triangles at apex, a pair of heavy seven-shaped spots on middle and basal pair usually almost divided into four longitudinal dashes. Veins of elytra more or less evenly bordered with fuscous.

Genitalia: Last ventral segment of female about twice as long as preceding, lateral margins excavated from about middle to rounded lateral corners, exposing large underlying membrane, posterior margin straight with small notch either side of broad truncate median portion. Valve of male about twice as long as preceding segment, roundingly obtuse; plates broader at base than valve, lateral margins straight, slightly narrowed to truncate apices; pygofer with large overlapping apical hooks on ventral margin; styles with apical third sharply narrowed, curved out; aedeagus in dorso-ventral view widened on outer third, with lateral margins of this portion serrate.

Holotype male, allotype female and numerous paratypes, Mafeking, Manitoba, August 3, 1937, R. H. Beamer.

6. **Memnonia acuta** n. sp. Fig. 6.

Resembling **Memnonia albolinea** Ball, but smaller and with the vertex much more acute and base of vertex decidedly more convex. Length, male 3.25 mm., female 5.25 mm.

Vertex distinctly less than a right angle, also acutely angled with front; anterior fourth very flat, remainder steeply convex. Wings of female short, exposing 4 segments of abdomen, male wings usually entirely covering abdomen. Venation distinct in female, apical cells much reduced. In male venation indistinct due to intense black color.

Color: Females vary from cinereous with dusky veins to a specimen that has the following dusky portions: most of vertex; six broad longitudinal bands on

pronotum, four of them extended over scutellum; all veins; a lateral longitudinal stripe and a median pair of vittae more or less disconnected, on the abdomen; almost entire dorsal surface. Males are solidly black throughout with the following light marks: line on vertex margin from eye to eye, ivory; seven longitudinal lighter stripes on pronotum, three often extending on scutellum; occasionally 2 lighter dashes at base of vertex and a semblance of light areas in apices of antiapical cells and bases of apicals. Venter of male black except posterior margin of last three abdominal segments lighter.

Holotype male, allotype female, two female and numerous male paratypes, Little Beaver Creek, Colo., July 11, 1937, R. H. Beamer.

7. **Deltocephalus luteoapicalis** n. sp. Fig. 7.

Resembling **Deltocephalus flavicosta** Stal, but smaller and dorsum entirely black except anterior third of vertex, narrow stripe on costal margin, two arcuate dashes just before apex on costal margin and a narrow border at apex cinereous to yellow. Length female 2.5 mm.

Structure: Vertex rather long and pointed, slightly less than a right angle; median length greater than length between eyes. Elytra scarcely as long as abdomen.

Color: Dorsum black except slightly more than anterior third of vertex and narrow stripe on costal margin from humerus to slightly beyond middle lemon yellow and two arcuate dashes on costal margin just before apex and a narrow line at apex cinereous. Eyes and front black, clypeus and most of cheeks lemon yellow; thorax and anterior portion of legs light, most of abdomen and outer portion of legs dark.

Genitalia: Last ventral segment of female about three times as long as preceding; broadly rounded on lateral margins to expose underlying membrane for its entire length, posterior margin broadly rounded to a shallow notch either side of a definite median tooth of about same height as lateral lobes.

Holotype female, and two female paratypes San Antonio, Texas, July 4, 1936, R. H. Beamer; other paratypes as follows: two females, George West, Texas, July 4, 1936, D. R. Lindsay; two females, Elmendorf, Texas, July 3, 1936, R. H. Beamer.

8. **Parabolocratus nimbosus** Ball Fig. 8.

About 50 specimens of this beautiful species were taken from bunch grass near Chama, New Mexico. They range from straw-colored individuals with irregular sided, median longitudinal black stripe on vertex, pronotum and scutellum, to specimens that are entirely black. None of the specimens, however, has the cross-banded dark marking of the following species.

9. **Parabolocratus nigrafasciatus** n. sp. Fig. 9.

Resembling **Parabolocratus nimbosus** Ball but color on vertex and pronotum in form of black cross-bands, disc of vertex more convex and front more abruptly expanded. Length: female, 7.25 mm; male, 5 mm.

Vertex of female about as long as wide, male slightly wider than long; lateral margins in female parallel for about half their distance, then evenly curved to apex; male vertex about as outer half of female. Both disc of vertex and face more strongly inflated than in **P. nimbosus.** Elytra in female shorter than abdomen, exposing about 2 segments; in male may be either considerably longer than abdomen or shorter.

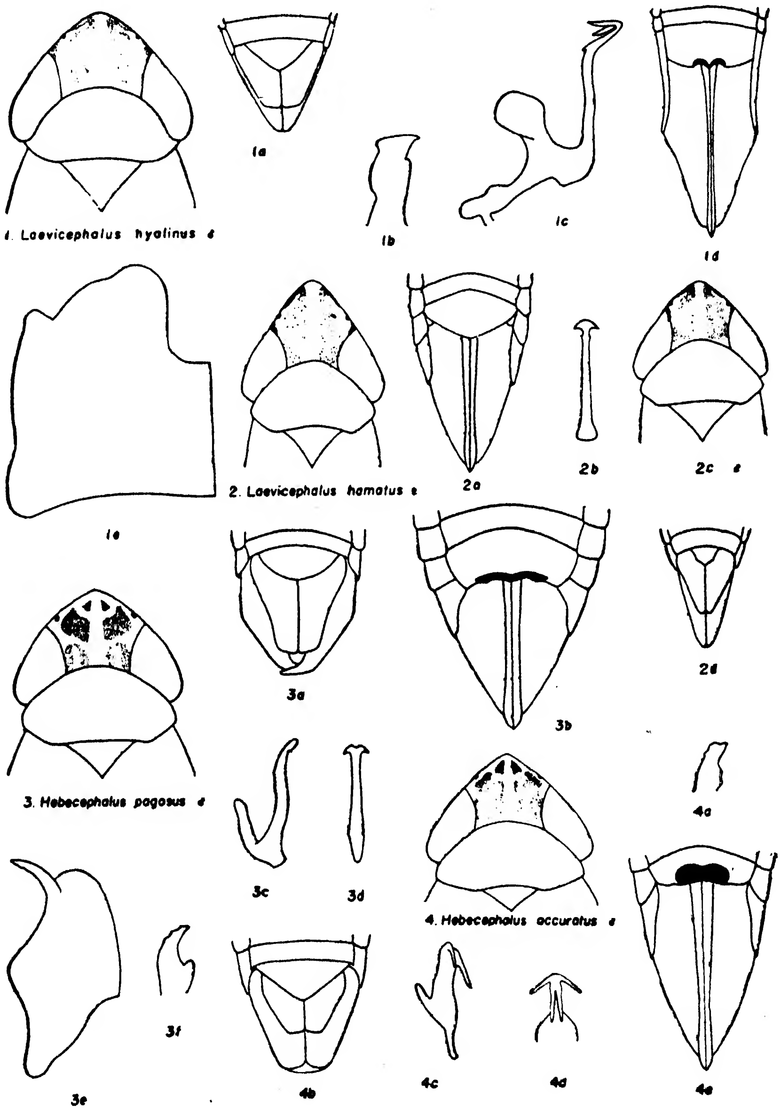
Color: General ground color stramineous with quite variable amounts of fuscous—from no black at all to quite dark individuals. Usually the black is as follows: vertex from anterior edge of eyes forward continuing below margin except a thin line on male on extreme apical margin; all of pronotum except narrow lateral border; apex of scutellum in female only; that portion of clavus inside outer claval vein except apex; oblong arc on disc of corium; more or less of surface of dorsum of abdomen exposed in female and in a majority of venter of male.

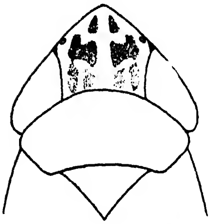
Genitalia: Last ventral segment of female about one-half longer than preceding segment, lateral margins rounded to slight median protrusion in form of three short, rounded lobes, median one slightly longest. Male valve about one-third as long as preceding segment; broadly rounded; plates wider at base than valve, rapidly narrowed to long, slender apices.

Holotype male, allotype female, three male and twenty female paratypes, Creede, Colo., July 6, 1937, R. H. Beamer; other paratypes as follows: one male and three females, same date and place, C. L. Johnston; two males and six females, same date and place, L. D. Tuthill.

This interesting species was taken in bunch grass by

grasping the bunches tightly with the hand and cutting them off at the surface of the ground, then shaking them out in the net. It was not uncommon to cut the specimens in half, indicating they stayed very close to the base of the plant.

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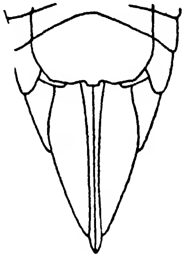
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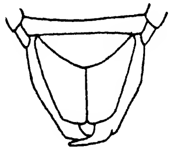
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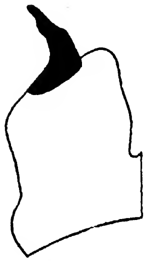
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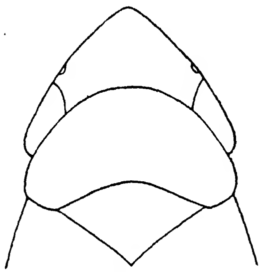
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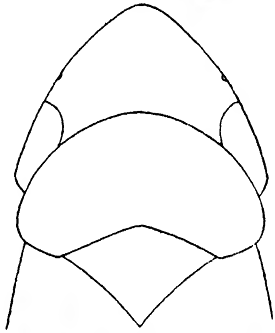
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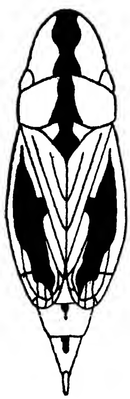
8. Parabolocratus nimbosus Ball


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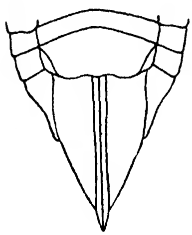
7. Deltocephalus luteoapicalis ♀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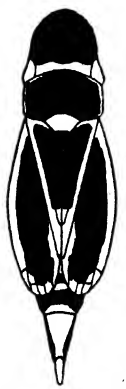

9. Parabolocratus nigrafasciatus

A THIRD NEW POTAMOBATES FROM PERU, S. A. (HEMIPTERA-GERRIDAE)

H. B. HUNGERFORD, Lawrence, Kansas *

In a recent shipment of material from the Department of Huanuca collected by F. Woytkowski is another new Potamobates which is described below:

Potamobates variabilis new species

Size: Length of wingless males 10.5 mm. to 10.9 mm.; of wingless females 9 mm. to 9.3 mm.

Color: Wingless forms only known. Black with light brown markings above; venter pale. Head light brown above with a somewhat elongate black spot. Antennae and tip of beak black. Pronotum with a pale brown triangular spot on dorsum and a silvery patch on the side behind each eye; the mesonotum solid black or with a faint slender median brown line on caudal half; lateral margins with longitudinal silvery stripe and silvery patches on meso-and meta-acetabula; abdominal dorsum black; all coxae and dorsal side of front trochanters and femora pale like the venter; front legs otherwise black, middle and hind legs brown, the femora longitudinally striped, above and below with black lines; connexivum black beneath or marked with brown spots that may be fused.

Structural Characteristics: Antennal formula of the male: 1st: 2nd: 3rd: 4th :: 60:20:21:30. First antennal segment a little longer than the width of the head through the eyes, tip of beak barely attaining anterior margin of front coxae. Pronotum a little shorter than the length of the head. Mesonotum of wingless male about 2.8 times as long as pronotum measured on median dorsal line; a median depressed line on caudal third of mesonotum. Front femora moderately incrassate with small peg-like projection on under side near distal end. Front tarsus of male a little more than one-fourth length of the tibia; the first tarsal segment a little less than one-third as long as the second. Formula for intermediate leg of male:- femur:tibia:tarsus :: 30.5:21:10.5. The first tarsal seg-

*Contribution from Department of Entomology, University of Kansas.

ment more than three times as long as the second. Formula for the posterior leg:- femur:tibia:tarsus :: 31.3:15:2. Posterior tarsus small, first segment longer than the second. The last abdominal tergite of the male slightly longer than the two preceding. In the male the connexivum is slightly produced behind. In the female the connexivum is produced into a long finger-like process about as long as the last abdominal tergite. The first genital segment of the male, measured on the median line, slightly longer than the last three preceding abdominal tergites. The general shape of this segment like that of **P. peruvianus** Hungerford, but having the caudal margin on the right side produced as shown in the drawings. The hook-like projection of the second genital while occupying the same position as in **P. peruvianus** Hungerford and **P. woytkowski** Hungerford is provided on its caudal margin with a large retrorsely and dorsally directed prong, a character which sets it apart from the group to which it belongs—which includes **Potamobates williamsi** Hungerford and **P. tridentatus** Esaki, beside the two mentioned above. The first dorsal genital of female triangular with caudal angle produced into a short, blunt, finger-like process which is but little, if any, longer than wide. The last ventral abdominal segment of the female (first genital) asymmetrical, its left side curled up over the side of the first dorsal genital.

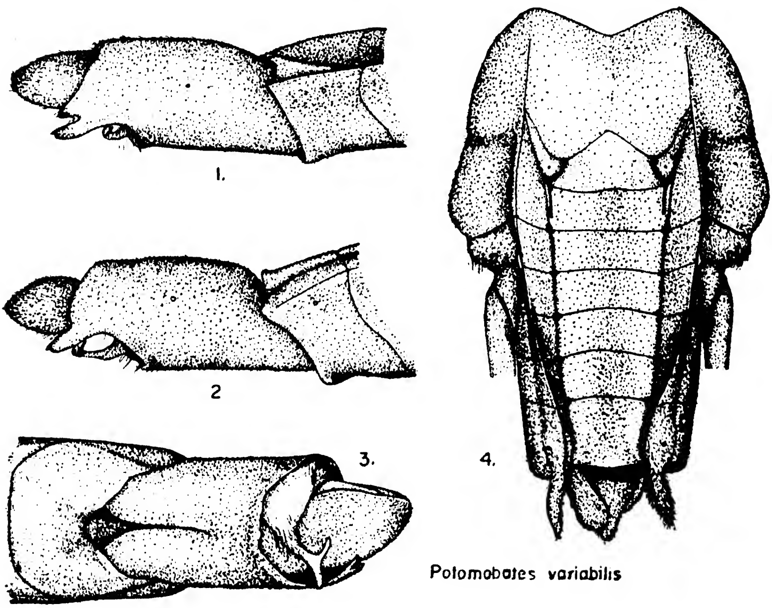
Location of Types: Holotype, allotype and paratypes in the Francis Huntington Snow Entomological Museum, University of Kansas. This species described from 12 males and 8 females, all wingless. Sixteen of them labeled: "Peru, S. A., June 10, 1937, F. Woytkowski, Dept. Huanuca, Vicinity of Afilador, Shady Jungle, 670 meters above sea level." The others taken between June 3rd and June 9th in Jungle at 800 meters above sea level, also in the vicinity of Afilador.

Comparative Notes: The males are readily recognized by the right caudal margin of the first genital, even though it shows considerable variation and by the prong on the second genital. The female, by having the finger-like processes of the connexiva shorter than the first dorsal genital, is separated from all but **P. tridentatus** Esaki, from which it differs in having the

caudal end of first dorsal genital short and blunt, instead of twisted and sharp-pointed as in Esaki's species.

Text figure—**Potamobates variabilis** Hungerford

1. Right side of male genital segments of holotype.
2. Right side of male genital segments of paratype to show variation in distal margin of first genital.
3. Ventral view of male genital segments of holotype.
4. Dorsal view of female abdomen of allotype.



A PRACTICAL TRAP FOR THE CONTROL OF HORN FLIES ON CATTLE.

W. G. BRUCE,
U. S. Department of Agriculture,
Bureau of Entomology and Plant Quarantine.

Since the importation of the horn fly, **Haematobia irritans** (L.), into the United States in 1887, various investigators have sought an effective method of control. Riley and Howard (1889), the first investigators, suggested the scattering of lime on the cow droppings to destroy the larvae. They also recommended the application of "almost any greasy substance" to infested cattle as a fly repellent. They specifically recommended "train-oil."

Parrott (1900) endeavored to furnish better protection to cattle against the attack of horn flies by constructing a trap that would catch and kill the flies and not merely repel them as was done by the application of horn fly mixtures. The general plan was to pass the cattle through a dark space or room. At the center of the room, in the roof, was a glass cupola, the sides of which were composed of four window sashes, with a large pane of glass for a roof. The trap was so designed that as the animal went under the cupola it passed through a doorway lined with brushes. It was hoped that the flies upon being disturbed would be attracted to the greatest light and would therefore swarm up into the cupola. He found, however, that it was impossible to get all the flies to remain on the animal until the brushes were reached. Parrott states, "Invariably, after the cows had entered the room for two or three feet the flies would suddenly rise up and pass out at the entrance doorway." The results obtained with this type of trap were most unsatisfactory, as only about 5 per cent of the flies were trapped.

Loughnan (1930) describes a fly trap he observed in Mauritius. He states that this is "a darkened building through which the cattle walk and brush off or disturb any flies which may be on them, and the natural tendency of these insects to seek the light is utilized to attract them into a destructor trap." From the description of the trap given by Loughnan the building is probably 10 feet wide by 20 feet long, with two lengthwise partitions so the cattle traverse the length of the building three

times in passing through. The author did not identify the flies caught in this trap but states that the species of flies most commonly found in Mauritius are **Stomoxys** and, to a small extent, the common house fly.

A cattle fly trap which gives promise of effective control of horn flies and of greatly reducing the population of stable flies, **Stomoxys calcitrans** (L.), has been designed by the Bureau of Entomology and Plant Quarantine. Observations indicate also that this device may be useful in capturing other flies attacking livestock. Many traps of this type, some of which are patented, have been developed by other workers. It is believed, however, that certain features of the trap described herein greatly improve the efficiency of such a device and make it more generally useful.

The trap is of simple construction and can be built at a relatively small cost. The framework of the trap is 5 feet wide, 6 feet high, and 10 feet long (fig. 1, **A** and **B**). The base of the frame is made of 2- by 8-inch lumber, the remainder of 2- by 4-inch lumber. All pieces are securely bolted together with 3/8-inch bolts. The top is made of any inexpensive lumber. The passageway through the trap is 33 inches wide and approximately 6 feet high and is lined along the sides with heavy large-mesh wire fencing. On each side of the frame, set side by side behind the wire, are three screen trapping elements, each 37½ inches wide, 10 inches deep, and 5 feet high (fig. 2). These screen trapping elements are made of 18-mesh, galvanized screen and are of a modified tent-trap construction—i. e., the screen of the trap facing the passageway is folded in a series of Z's (fig. 1, **D**, and fig. 2, **C**). The apertures through which the flies enter the trapping element are three-sixteenths by three-eighths inch and are placed three-fourths of an inch apart along the inner acute angles of the Z's (fig. 1, **D**, **a**). Each trapping element is provided with a door through which the dead flies are removed (fig. 2, **D**). Two sets of curtains and six weighted strips are used to dislodge the flies from the cattle as they pass through the trap. Each set of curtains consists of three pieces of carpet—two pieces 20 inches by 6 feet and one short piece 24 by 30 inches. The two long pieces of one set are attached to the frame at the top and sides of the passageway between the first and second pairs of trapping elements (fig. 1, **C**, **a**). These long curtains,

being fully one-half as wide as the passageway, meet at the center. The short piece is suspended from the top at the same place of attachment as the long curtains (fig. 1, C, b). This serves to brush the flies from the backs of the cattle and also to darken the space above the animal, which is opened by the parting of the long curtains. The other set of curtains is installed in the same manner between the second and third pairs of trapping elements. The weighted strips are made of carpet 4 inches wide and about 6 feet long and are suspended at irregular intervals from the top of the trap between the two sets of curtains. The weights consist of small pieces of lead, iron, or other heavy material weighing at least 4 ounces, which are riveted to the strips near the lower

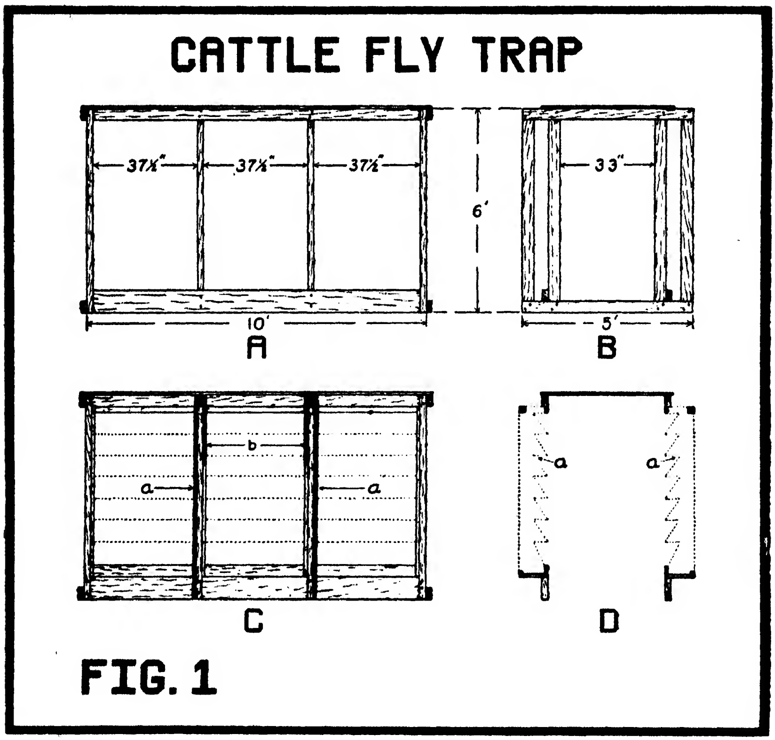


Fig. 1.—Drawings of cattle fly trap: A, Side view of frame; B, end view of frame; C, longitudinal section of trap, a, long curtains, b, short curtains; D, cross section of trap, a, a, two points where flies enter trap.

end. These weighted strips flap about the body and legs of the animal as it passes through the trap and dislodge flies not reached by the curtains.

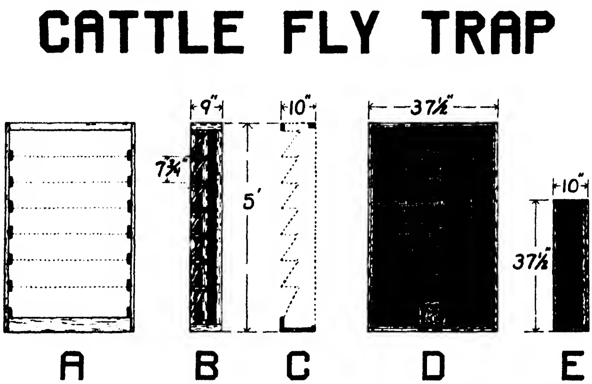


FIG. 2

Fig. 2.—Drawings of trapping element: A, Front view; B, interior view of one end showing construction of Z's for screen wire; C, cross section; D, back view (note door for removing dead flies); E, top view.

It will be noted that the placing of the Z-shaped trapping elements along the walls of this trap takes advantage of the tendency of horn flies to fly outward and upward when they are brushed from an animal. Stable flies also rarely fly directly upward. The construction of the trap is such as to allow as much light as possible to enter, particularly on the side walls of the entrance section. This feature prevents the escape of any great number of flies through the entrance opening.

The location of the trap is important. The preferred location is a lane through which the cattle travel to and from water. Another suggestion is to construct a fence around the water supply and place the trap in the gateway so the cattle will be compelled to pass through the trap on the way to and from water. This will insure frequent use of the trap, and, obviously, the more often the cattle go through the trap the greater will be the degree of control.

After the trap is set up the cattle should be permitted to pass through it for a week or more before the curtains are installed. The curtains are then added, piece by piece, at 2- or 3-day intervals. This precaution is necessary in order not unduly to alarm the animals, especially wild range cattle, while they are being familiarized with the trap. Ordinarily it will take 3 weeks or more before the trap is in full operation.

A cattle fly trap of the model described above was placed in operation in the summer of 1937 on a ranch at Cresson, near Fort Worth, Tex. (fig. 3). This 5,500-acre ranch was divided into a number of pastures of approximately 500 acres each. About 40 head of Hereford cattle grazed in each of these pastures. This particular ranch was selected as an ideal place for a trapping experiment because it was possible to check the numbers of horn flies on cattle having access to the trap against the numbers on cattle in adjacent pastures. There were no significant differences in the topography of the various pastures, or in the numbers of cattle in them. At the time the trap was installed the horn fly population was esti-

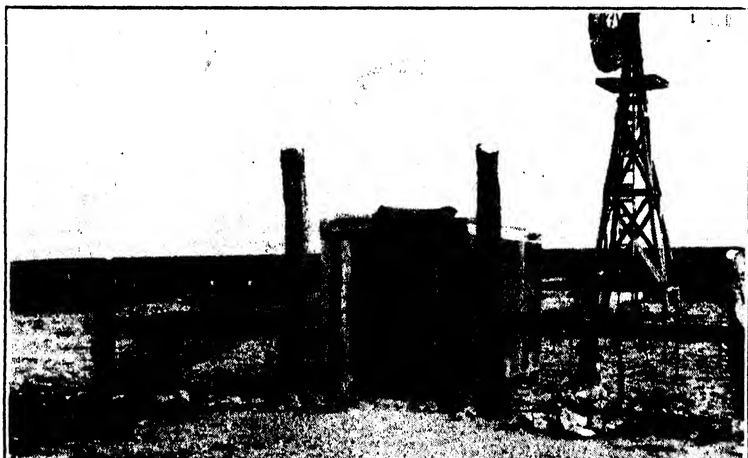


Fig. 3.—Photograph of cattle fly trap in operation on ranch at Cresson, Tex. (one curtain raised). Note wire to protect trapping elements.

mated at not less than 4,000 flies per head for cattle in all the pastures. In 2 weeks, and before all the curtains were installed, a 50-per-cent reduction of horn flies on cattle in the trapped pasture as compared with flies on cattle in adjacent pastures was recorded. After the third week the horn flies ceased to be troublesome in the trapped pasture. There was no reduction in the numbers of the horn flies on the cattle in adjacent pastures, and the flies were so troublesome that the cattle sought protection in the high weeds and brush and often refused to graze until nightfall.

It is indicated from these results that horn flies do not travel any considerable distance under range conditions and hence there is little likelihood of pasture reinfestations on this account, although reinfestation no doubt does occur to a certain extent from animals in adjacent pastures. The constant use of the trap, however, by the animals during the fly season would greatly reduce fly breeding and prevent the building up of a large fly population.

Another trap of similar design was operated on the laboratory premises of the Bureau of Entomology and Plant Quarantine at Dallas, Tex., where four heifers were used as experimental animals. At no time after the trap was installed were more than 10 horn flies found on any one animal, though hundreds of horn flies were released on these cattle from time to time.

A third trap of similar design, operated at a dairy near Dallas, Tex., was highly satisfactory in controlling horn flies and in greatly reducing the population of stable flies.

The trap described herein is not yet considered perfect, but the results obtained in 1937 clearly demonstrate that the cattleman can now be provided with a practical, efficient, and economical fly trap that will control horn flies.

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OBSERVATIONS ON ROACH REPRODUCTION

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Over a period of seven years I have been using roaches (**Blattella germanica** L.) as test animals in nutrition and growth research. Naturally, during the course of these investigations I have handled an enormous amount of material and much interesting as well as valuable information has been gained. With no definite object in mind I have recorded these observations and in publishing them here I make no attempt to cover the whole field of reproductive biology, but rather to point out those features which may be of interest or of practical value to those who contemplate using this insect as a laboratory convenience.

It is a well known fact that all roaches produce their eggs in an enclosing capsule which is carried by the female for a greater or lesser period of time, clasped in an external pocket formed between the sterna and terga of the posterior abdominal segments. Not so well known is the fact that the German roach retains the capsule until, or immediately before, the hatching of the eggs. Other roaches may, and usually do, deposit their oothecae after a few days, leaving their safety in the hands of chance, but this species retains the egg case at least until a very few hours prior to eclosion, often until all of the young have gained their freedom. As is commonly the case with the American roach, I have never seen free, viable capsules in the rearing cages. Spent capsules are frequently found in the vicinity of food, surrounded by the young nymphs, indicating that they may have been discarded within a few hours of hatching. On the other hand, I repeatedly have seen nymphs emerging from capsules still in the grasp of the mother. When experimental procedure demanded that oothecae be removed early for sterilization, considerable difficulty was encountered in inducing eggs so treated to hatch. As a matter of fact, capsules allowed to remain in position in the grasp of females, which had been killed mechanically, seldom hatched. A few days (usually within 72 hours) prior to hatching, a dark band appears along the mid line of the case, resulting from the accumulation of meta-

* Contribution from the Department of Entomology, University of Kansas.

bolites within the alimentary canals of the developing embryos. Capsules removed before the appearance of this indicator invariably failed to hatch, and many also failed unless detachment had been delayed for two or three days.

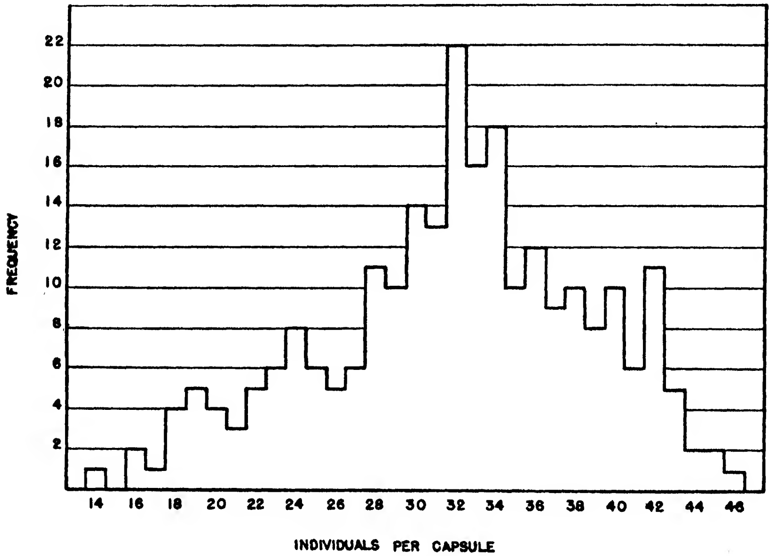
Adults may mate within a few days following the last moult and eggs are generally produced a short time thereafter. Considerable variation was found in the time elapsing between the appearance of the capsule and eclosion. Temperature, food, and possibly other factors affect this incubation period, but under average conditions about two weeks are required for the development of the embryos.

Repeated copulation has been observed for several females, but on the other hand a single mating may suffice for the fertilization of all the eggs produced during a lifetime. I had noticed that isolated females were able to produce more than one capsule to a mating and to test this point I chose five virgin females which had been reared from the egg. These were allowed to mate once and then isolated in separate cages from which the young were removed as hatched. Female No. 1 lived 155 days during which time she produced three capsules and a total of 85 young. Female No. 2 was killed accidenatlly while carrying her second capsule, 36 young having hatched from the first. Female No. 3 produced three capsules and 90 young during her life period of 192 days. This individual lived until September 23 after hatching her last young on June 8 and she alone, among the five, lived long enough to develop more oothecae had subsequent matings been allowed. Four capsules and 118 young in 122 days was the accomplishment of female No. 4. The last female, No. 5, lived 129 days and produced 88 young in three capsules.

No direct data were kept on the length of adult life or upon the total number of eggs produced. Several females lived in confinement in four ounce bottles for a period of six to ten months during which time each produced from four to as many as seven capsules.

That this roach is a prolific breeder is attested by the size of the clutch emerging from each ootheca. No attempt was made at dissection to determine the actual number of eggs in each case since to do so would have destroyed the viability of embryos needed in other ex-

periments. However, records of the number of nymphs emerging have accumulated for 246 capsules, and these data are shown graphically in the accompanying figure. The average for the entire lot is 31.9 plus or minus 0.291.



Frequency distribution for number of nymphs hatching from oothecae.

A STUDY OF THE INCIDENCE AND HABITS OF COCHLIOMYIA AMERICANA BY MEANS OF FLYTRAPS [1]

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In the vicinity of Uvalde, Tex., females of **Cochliomyia americana** C. & P. have been found only on wounds of warm-blooded animals, carrion, and fresh cow dung. Carrion seemed to be quite attractive to the female fly. Males were rarely observed on carrion, but were occasionally seen on cow dung. Females have been observed feeding on the carcasses of rabbits, squirrels, opossums, deer, sheep, goats, and calves.

In the spring of 1935 it was found that **Cochliomyia americana** could be caught in liver-baited fly traps in appreciable numbers. This suggested a useful supplemental means of studying the seasonal activity, relative abundance, and dispersion of the adult fly, especially in areas where the presence of the pest might not be indicated by infested animals, owing to the absence of susceptible wounds.

Since **Cochliomyia americana** is attracted to traps, and the number caught represents previous infestations in animals and suggests the degree of danger of future infestations, it is believed that the use of liver-baited fly traps will be of some value for studying certain biological relationships and in predicting local outbreaks of this species.

The data presented herein were obtained from collections of flies from a status trap (standard Government fly trap) (Bishopp 1916) operated continuously in the same location at Uvalde, Tex., from July 15, 1935, to October 30, 1937. The trap was set 3 feet off the ground in a mesquite tree in a native pasture and baited with 2 pounds of beef liver and 6 quarts of water. It was emptied twice a month. Additional data were collected from similarly operated traps set within a distance of 5 miles of the status trap. These traps were operated only during the period from May 9 to August 13, 1936.

1 Acknowledgment is made of the assistance and suggestions given by D. C. Parman.

Because **Cochliomyia americana** closely resembles **C. macellaria** F., the common blowfly of the Southwest, the determination of the former species in large catches of flies is difficult. In these studies the number of **C. americana** in relation to the other species of blowflies rarely exceeded 0.5 per cent. The catches of flies were weighed, and either an entire catch or a sample comprising from one-third to one-eighth of the flies was examined for the number of **C. americana**; then the total number present was computed.

Incidence of adults of Cochliomyia americana.—Figure 1 shows the number of females of **C. americana** caught in the status trap. The fly population in March 1936 and March 1937 was indicated to be very low, but a gradual and definite increase is shown until the peak in June, 1936. A decided drop in the fly population is shown during the hot, dry weather in August and September 1935, and in July and August 1936 with slight increases again during the fall months when the temperatures were lower. Data for other periods in 1937 given in Table 1 show that a peak in fly abundance was reached in June and a rapid decline in numbers took place during July and August followed by slight increases during the fall months.

The low catch of 25 flies on July 15, 1937, appears to be at variance with the catches of other years, but this might have been the result of the removal of the sheep

Table 1.—Mean temperature, rainfall, and numbers of **Cochliomyia americana** caught in a fly trap for certain periods during 1937. Uvalde, Tex.

One-Half Month Period Ending	Mean Temperature	Rainfall	Cochliomyia americana caught
	Degress F.	**Inches**	**Number**
June 15	81.0	2.79	93
June 30	84.6	.01	222
July 15	83.4	.77	25
July 31	86.8	0.00	92
August 15	88.2	0.00	42
August 31	87.1	0.00	6
September 15	84.4	1.76	16
September 30	78.1	.02	48
October 15	77.0	.73	13
October 31	68.7	.86	77

and the burning of the pasture, for another trap 3 miles distant caught 140 flies during the same period.

The sudden increase in the population of the fly in the first part of January 1936, and in the last part of December 1936 and first part of January 1937, is explained by the fact that cool weather prior to these periods had been retarding the emergence of adults from larvae that had dropped from infested animals during November. With the advent of a warm period, as shown in fig. 1, the emergence of **Cochliomyia americana** was considerable, as indicated in overwintering tests, and a large catch in the trap resulted. Larvae of **C. americana** that dropped in outdoor cages at the laboratory in November emerged during the time these large catches were being made in December and January.

The increased fly population was not accompanied by an immediate and proportionate number of screwworm cases, although wounds on animals were prevalent because of docking and castration of sheep on various ranches. Cases began to appear in numbers, however, a few days later. Since no infestations occurred immediately, with the large number of flies present, it appeared that this brood of flies was in the preoviposition stage and that at least a considerable number were seeking food at carrion prior to oviposition on animals. This observation is supplemented by the data presented later in this paper on the comparison of the egg development in the flies caught over wounds and over carrion.

In general, the population trend of **Cochliomyia americana** followed the incidence of screwworm cases in livestock. It is common knowledge among the ranchmen in Uvalde County that during March and April, 1935 to 1937, the screwworm infestations in livestock were comparatively light, but that, as the season advanced, cases became more and more numerous until June or July. Infestations became less frequent during the hot summer months. With the advent of fall and cooler weather the number of cases again increased. The foregoing information is confirmed by frequent observations and collections of larvae in animals. Screwworm cases were much easier to locate in May and June, and more difficult late in the summer and late in the winter.

The temperatures in fig. 1, which are the daily mean averages for each half month, indicate the fly activity, in

so far as flight and feeding are concerned, occurred from semimonthly mean temperatures of 45.3 degrees to 88.2 degrees F. Fig. 1 also shows that the population of **Cochliomyia americana** fell off considerably and quite rapidly when the mean temperature during the summer months reached 80 degrees or above, especially when rainfall was light. Low winter temperatures were also effective in decreasing the number of flies. The population was reduced to near zero during February and March, 1936 and 1937.

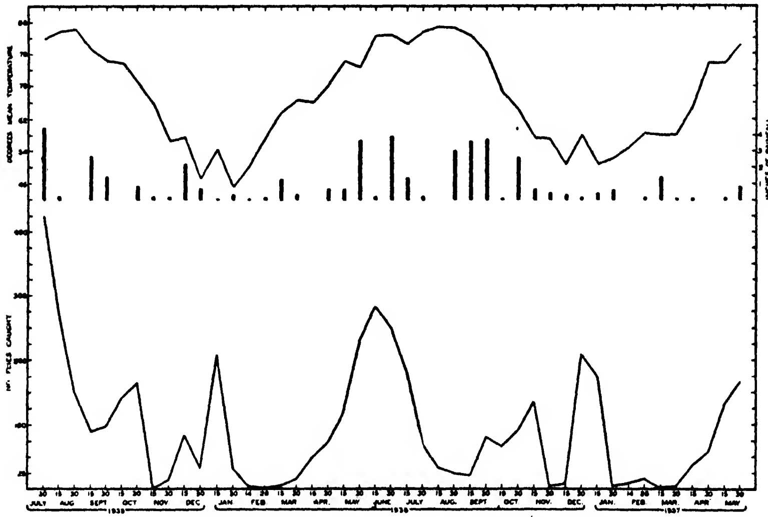

Fig. 1.—The numbers of **Cochliomyia americana** caught in a liver-baited fly trap, together with mean temperatures and rainfall, July 15, 1935, to May 30, 1937. Uvalde, Tex.

The ratio of Cochliomyia americana to C. macellaria.—Laake et al. (1936) gives the comparative abundance of **C. americana** and **C. macellaria,** as determined by the attractiveness of wounds, as 1 of the former to 590 of the latter. The ratio of the two species taken in a standard meat-baited fly trap during a 7-day test at Menard, Tex., showed 1 of **C. americana** to 2,427 of **C. macellaria.**

At Uvalde, Tex., the ratio of **Cochliomyia americana** to **C. macellaria**, as determined by the liver-baited status trap, averaged 1 to 912, with a range of 1 to 36 to 1 to

10,962 during the 27½ months of the study. Usually about one-half of the **C. macellaria** caught in traps were males whereas only the females of **C. americana** came to the traps, which would make the average ratio of the two species approximately 1 to 456. The average ratio of **C. americana** females to **C. macellaria** males and females during December 1935, and January and February 1936, was 1 to 103, and during the same period in the next winter was 1 to 100, which indicates that **C. americana,** as compared to **C. macellaria,** was a great deal more abundant during the winter months than the average for the year. A study of the ratios occurring in the winter indicates that low temperatures decreased the population of **C. macellaria** to a greater extent than it did that of **C. americana.**

A 10-day test in September 1935 showed a ratio between **Cochliomyia americana** females and **C. macellaria** males and females of 1 to 191, as determined by the attractiveness of an infested goat, and 1 to 2,896, as determined by the attractiveness of liver. In this test 28 **C. americana** were caught in an improvised screen trap on a wounded goat, and 96 were captured in a standard trap baited with liver. A similar 15-day test in July, 1936 showed a ratio of the two species of 1 to 33 on infested wounds of sheep in another type of screen trap, and 1 to 1,000 over liver. In this instance, 98 of **C. americana** were caught on the wounds and 224 over liver. While it is obvious that several unconsidered factors may have decreased the accuracy of these comparisons, the data are presented here to indicate the results that might be expected from similarly conducted tests.

It is evident that the comparative abundance of the two species as indicated by the numbers attracted to wounds and traps varies according to the season, the attracting media, and very probably according to differences in local environment. Whether the numbers trapped on liver or on wounds indicate the exact ratio of the two species as they exist in nature is not known, but it is significant that carrion, which has not been found to breed **Cochliomyia americana** is to a certain degree attractive to the females of this fly.

The number of Cochliomyia americana caught in traps.—The status trap caught 4,845 females of **C. ameri-**

cana during the period of study. The largest 15-day catch was in July 1935, when 425 were taken. Three catches, collected November 15, 1935, February 29, 1936, and March 15, 1937, failed to disclose any of **C. americana.**

From May 9 to August 13, 1936, one to three liver-baited traps were operated intermittently for 10-day periods within 5 miles of the status trap. During these periods, comprising 115 trap days, 2,312 females of **Cochliomyia americana** were caught, with an average daily catch per trap of 20.1, a maximum of 29.7, and a minimum of 10.8. The status trap, which was operated for 15-day periods, caught an average of 11.5 of **C. americana** per day during the same period. This indicates that liver bait is probably more effective in the shorter period and that the location of a trap is a factor in the catching of **C. americana.**

The egg development of Cochliomyia americana caught in traps.—With the object in view of learning something about the oviposition habits and longevity of **C. americana** caught in traps, live females were taken out of traps at frequent intervals, brought to the laboratory, and put into small cages under insectary conditions. As the flies died they were dissected and the size and development of the eggs determined. The state of development of the eggs was designated as (1) large, apparently fully developed, (2) partly developed, and (3) immature. It was early demonstrated that flies caught in traps would oviposit viable eggs on wounds of animals.

A study of 251 flies caught from April to December, 1936, showed an average longevity after capture of 3.4 days, with a maximum of 38.7 days and a minimum of 1 hour. There is no doubt that the remaining life was shortened by congested conditions in the trap, and the

Table 2.—The egg development in **Cochliomyia americana** flies caught in liver-baited traps.

Time Flies Lived after Removal from Trap	Percentage of flies containing—		
	Large Developed Eggs	Partly Developed Eggs	Immature Eggs
36 hours or less	15.7	19.3	65.0
Over 36 hours	37.2	8.5	54.3
Average	24.3	14.9	60.8

handling of the flies in small cages. It is concluded that the life of some females of **Cochliomyia americana** is not at an end when they are attracted to carrion; rather, it appears that a comparatively long life is yet to be consummated.

In Table 2 is shown the status of the ova in the flies that lived less and those that lived more than 36 hours after removal from the trap.

Of the flies that lived 36 hours or less, 15.7 per cent contained large, developed eggs at death, whereas in those that lived over 36 hours, 37.2 per cent contained developed eggs, which indicates considerable development of the eggs with age of the flies. It must be stated, however, that the feeding of the flies was infrequent and inadequate for egg production. The egg development in the flies caught over liver ranged from small to large, but 65 per cent of the 36-hour-old flies contained small or immature eggs. A similar percentage was found in flies that were killed immediately upon capture over various carcasses.

In contrast to flies caught over liver bait, the examination of 112 flies caught on infested wounds of animals showed that 89 per cent contained large, developed eggs, apparently ready for oviposition. These flies were killed and examined 24 hours after capture.

These data show that 65 per cent of the flies attracted to liver, and 11 per cent of those attracted to wounds, contained small or immature eggs. Carrion, apparently, was a preferred feeding medium and most of the flies visiting it were probably in the preoviposition stage. Wounds, also, were feeding places, but the records indicate that the majority of flies came there apparently ready to oviposit.

Summary and conclusions.—Decaying flesh was found to be an important feeding material for **Cochliomyia americana,** and liver-baited fly traps were valuable in the study of the adult population of the pest.

The incidence of **Cochliomyia americana** females increased gradually during the spring and showed a rather rapid decline during the hot, dry weather of the summer with a rise again in the fall. During the late winter season the fly population was reduced to the lowest numbers of the year. In general, the fly population followed the incidence of screwworm cases in animals.

An average of 20.1 **Cochliomyia americana** were caught per day per trap, when liver was used as bait, in the spring and summer of 1936.

Trap-caught flies oviposited viable eggs on wounds on animals and lived an average of 3.4 days after being taken out of traps. The majority of the flies caught over liver bait were indicated to be in the preoviposition stage while those caught on wounds were apparently ready for oviposition.

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GONIODES CENTROCERCI, A NEW MALLOPHAGAN FROM GROUSE.

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During the last several years nearly a hundred sage grouse from various localities in Wyoming have been examined by parasitologists on the staff of the University of Wyoming Agricultural Experiment Station. Only two species of Mallophaga were taken from these birds: **Lagopoecus perplexus** Kellogg and Chapman, 1899; and **Goniodes centrocerci** n. sp. here described. The latter is considerably more common.

Described from 82 individuals; 29 immature, 42 female, and 11 male; collected from sage grouse in Wyoming and Montana as follows: 13 specimens from Fergus County, Montana, 1931, loaned, for this study, by the Rocky Mountain Laboratory at Hamilton, Montana; 22 specimens from the region of Daniel, Wyoming, 1934, by George L. Girard; 4 specimens from the region of the Graham Ranch, Wyoming, 1934, by John W. Scott; 8 specimens from the region of Wallrock Canyon near Laramie, Wyoming, 1936, by Felix Simon; and 35 specimens from the region of Battle Mountain, Wyoming and the Miller Hill Refuge, Wyoming, 1937, by Ralph F. Honess and Felix Simon.

Description of male: Head 1.24 times as wide as long; widest at apex of angulate temples; forehead widest just in front of antennae. Occiput concave posteriorly. Trabeculae absent, but postero-lateral expansion of forehead partially covering antennal fossa anteriorly. Eyes prominent, bordering antennal fossa posteriorly; thick cornea clear, bearing single, long ocular seta. Pharyngeal sclerite prominent. Color light brown. Antennae short, capable of extending backwards as far as the lateral apex of the temple; first segment greatly enlarged and as long as the last three combined; second segment not quite so long as the last three combined; process of third segment projects mediad and is larger than the rest of the segment; fourth and fifth segments about the same size. One long seta mediad to each eye; one in the fossa just anterior to each antenna; one long seta and one very short, spike-like seta on each lateral apex of the temples; and one, rarely two, long setae in each posterior concave face of the temples.

Thorax two-thirds as long as head, light brown in color with darker margins. Prothorax roughly trapeziform, with a dorso-lateral seta near each posterior angle. Pterothorax with two dorso-lateral setae near each posterior angle, and two dorsal setae a third of the way mediad from each side. Progressing posteriorly the legs become successively longer, and the coxae more widely separated.

Abdomen of nine segments, short, with rounded sides; widest at segment four; the first segment longest; segments two to five about equal; six to eight becoming successively reduced with sides increasingly rounded forming a truncate posterior end, the truncate appearance being broken by the extrusion of the ninth segment. Lateral abdominal bands are deep and conspicuous. Spiracles on segments two to seven inclusive. Chaetotaxy: Segment one: two or three lateral setae near each posterior angle, and two to four dorsal setae about a third of the way mediad from each side. Segments two, three, and four: three lateral setae near each posterior angle; two or three behind each spiracle. Segments five and six: four lateral setae near each posterior angle; two or three behind each spiracle. Segment seven: the setae near the posterior angle and those behind the spiracle are confluent, forming a row of eight or nine on each side. Segment eight: two setae at each posterior angle. Segment nine: more than twenty setae in all. There are

a few mid-dorsal setae on all segments except six, seven, and eight. Each of segments two to seven bears two setae near the middle of the sternite. Segments eight and nine have a few ventral setae. There may be one or two small, adventitious setae with those behind the spiracles on segments two to seven, or with those a third of the way mediad on segment one.

Description of female: Head as in male except larger and angles of temples sharper. Antennae shorter; segment two is longer than segment one, though not so long as the last three segments combined. Segment three bears no process.

Thorax as in male but comparatively shorter and wider.

Abdomen similar to male but longer and more ovoid, being without the truncate appearance. Ninth segment not extruded beyond eighth. Segments one to seven bear five to six mid-dorsal setae. There are two lateral setae at the anterior angle of the eighth segment, as well as two at the posterior angle. Only one large seta on each side of the ninth segment. Seventh segment bears a pair of cerci.

Average measurements in mm.

	Male		Female	
	Length	Width	Length	Width
Head	0.623	0.784	0.708	1.009
Thorax	0.421	0.641	0.440	0.716
Abdomen	1.067	1.101	1.476	1.224
Total	2.111		2.624	

Immature forms with the same chaetotaxy and of the same general shape except for comparatively larger and more rounded abdomens.

Type host: Sage grouse, **Centrocercus urophasianus**

Type locality: Battle Mountain, Wyoming. Paratypes from Miller Hill Refuge, Wyoming; Daniel, Wyoming; Graham Ranch, Wyoming; Laramie, Wyoming; and Fergus County, Montana.

Type slide: U. S. N. M. Number 52636. Paratypes in the parasitology collection of the Experiment Station at the University of Wyoming.

Discussion: By way of distinguishing **G. centrocerci** n. sp. from related species and from species infesting hosts closely related to the sage grouse: **G. cupido** is less than half the size of **G. centrocerci** n. sp. The head of **G. mammillatus,** a very similar species, is longer than wide. **G. cervinicornis** is fifty per cent larger than **G. centrocerci** n. sp., and the male bears a process on the first antennal segment. **G. tetraonis** and **G. dissimilis** are less than half the size of **G. centrocerci** n. sp.; also **G. dissimilis** bears a spiracle on the first abdominal segment according to Nitzsch's plate in Denny. Although Packard's description of **G. merriamanus** suggests a very similar form, the drawings accompanying the description are distinctly different from **G. centrocerci** n. sp. Packard states that the antennae are four segmented, but his drawing of the female shows three segments, of the male, five.

Between the Sandstone Ranger Station and Battle Mountain, not far from the latter, 42 Mallophaga of the genus **Goniodes** were collected from the blue grouse **Dendragapus obscurus obscurus** by Ralph F. Honess and Felix Simon, 1937. Although there were slight differences in the male genitalia, these lice were identified as **G. centrocerci** n. sp.

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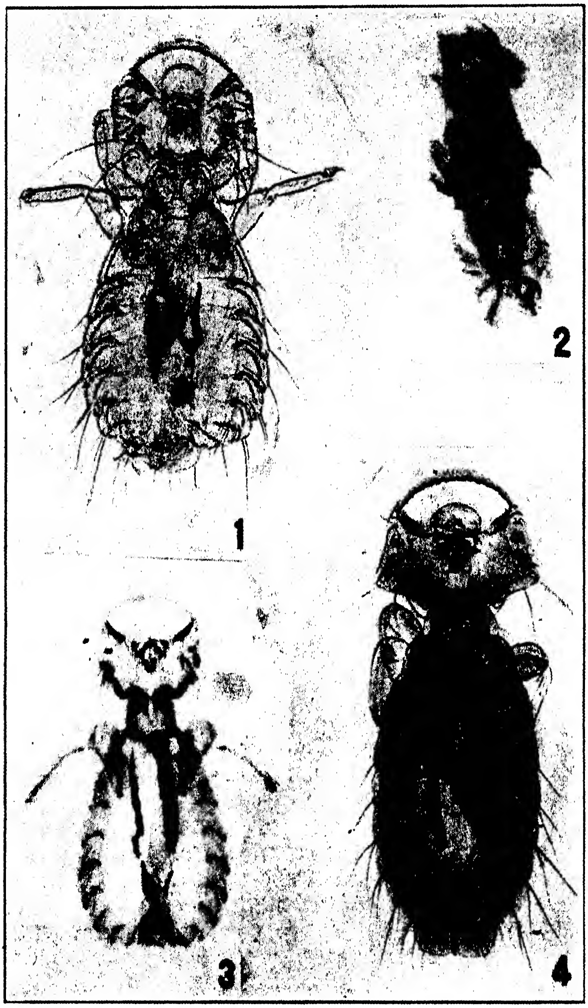

EXPLANATION OF PLATE

Figure 1. **Goniodes centrocerci n. sp. male.**

Figure 2. **Goniodes centrocerci n. sp. male genital armature 97 x.**

Figure 3. **Goniodes centrocerci n. sp male, showing genital armature in situ.**

Figure 4. **Goniodes centrocerci n. sp. female.**

BLOOD PULSATIONS IN EUXOA DETERSA (WALKER)

DON B. WHELAN
University of Nebraska, Lincoln, Nebraska

Because of the unpigmented condition of the skin, the cutworm **Euxoa detersa** (Walker) offers a good opportunity for studying the pulsations of the dorsal blood vessel. On June 23, 1937, a few such observations were made on these larvae, but no records were kept of surrounding environmental conditions, such as temperature and humidity. Sixteen cutworms were observed and the number of pulsations per minute were recorded. Each individual was confined in a tin salve box along with food and a small amount of sand. Two observations were made on each individual. First, the pulsations were counted when the cutworm was undisturbed, as shown in column I of the table below. Then the larva was prodded into movement, and the second observations were made, as recorded in column II of the table. The count on the undisturbed cutworms showed a variation from 8 to 48, with an average of 26.5, for the sixteen cutworms, while the count taken after they were disturbed varied from 10 to 60 with an average of 34.5. The summary of the counts taken are shown in the following table:

Cage No.	Locality Collected	Pulsations per Minute I	II
1.	West Point, Neb.	48	60
2.	West Point, Neb.	34	40
3.	West Point, Neb.	40	40
4.	West Point, Neb.	22	28
5.	West Point, Neb.	24	24
6.	West Point, Neb.	24	40
7.	Pierce, Nebr.	10	18
8.	Pierce, Nebr.	40	50
9.	Pierce, Nebr.	18	28
10.	Pierce, Nebr.	42	46
11.	Pierce, Nebr.	26	30
12.	Pierce, Nebr.	10	30
13.	Pierce, Nebr.	30	48
14.	Pierce, Nebr.	8	14
15.	Pierce, Nebr.	40	46
16.	Pierce, Nebr.	8	10
Average		26.5	34.5

Minutes of the 14th Annual Meeting of the Kansas Entomological Society—Kansas State Teachers College, Pittsburg, Kansas, April 2, 1938

Business Meeting.

Vice President L. C. Woodruff called the meeting to order at 10:00 A. M. in room 203, Carney Hall, and at his suggestion those present stood in silence for one minute in memory of our deceased President, Dr. Warren Knaus.

The minutes of the 13th annual meeting were read and approved.

Reports of Officers.

The secretary-treasurer's report was read and approved. A summary of the report is as follows:

Receipts, April 1, 1937 to March 31, 1938	$716.41
Disbursements, April 1, 1937 to March 31, 1938	496.78
Balance	$219.63
Assets: U. S. Savings bonds, maturity value $850.	$637.50
Accounts receivable	13.89
Balance in checking account	219.63
	$871.02
Liabilities: Due on separates, uncollectable account	4.78
Net Assets, March 31, 1938	$866.24

Report of Editor: —not received

Appointment of Committees:

Vice President Woodruff appointed the following committees: Resolutions:—H. B. Hungerford, Ralph Voris,.. Roy Fritz.

Nominations:—R. C. Smith, R. H. Beamer, Dwight Isely

Auditing:—H. R. Bryson, L. S. Henderson.

Old Business:—none

New Business:

At the written request of R. L. Parker, the question of reducing the price of reprints was introduced. The opinion of the meeting was that no action should be taken at the present time, early publication of manuscripts more than out-weighing any other consideration.

Then followed the presentation of papers, the program consisting of 16 titles as follows:

1. The Identification of Burrowing Insects by their Burrow Characteristics. Harry R. Bryson, K. S. C.

2. Observations on the Ecology of the Corn seed beetle (**Agronoderus pallipes** Fab.) Franklin Dillon, D. S. C.

3. Some Notes on the family Belostomatidae of the Western Hemisphere. D. Warren Craik, U. of K.

4. Report on some New Species of Water Bugs. H. B. Hungerford, U. of K.

5. Variation in **Habrodais grunus** (Boisd). Lepidoptera: Lycaenidae. Wm. D. Field, U. of K.

6. Some notes on Curculionidae, Lyman S. Henderson. U. of K.

7. The Oviposition of Corixids upon Crayfish. Melvin E. Griffith, U. of K.

8. Corixid Eggs as Human Food in Mexico. H. D. Thomas, U. of K. Motion picture.

9. Possible Physiological Factors in the Distribution of Notonecta in Mexico. H. D. Thomas, U. of K.

10. Observations on the 1937 Grasshopper Survey. Roland W. Portman, K. S. C.

11. The Internal Sac of the Male Genitalia as Taxonomic Character in Phyllophaga. Milton W. Sanderson. U. of Ark., Fayetteville.

12. Some Entomological Observations made during Termite Inspections. C. R. Rogers, Wichita.

13. Chrysopidae Seen in European Museums. R. C. Smith. K. S. C.

14. Fluctuation in the Grasshopper Population in Grass Lands during the Drouth Years, 1933-1937. Donald A. Wilbur and Roy Fritz, K. S. C.

15. Parasites Reared from the Strawberry Leafroller (**Ancylis comptana** Froel). Ralph L. Parker and Paul G. Lamerson, Kan. Agr. Exp. Sta.

16. Preliminary Report on Distance as the Isolating Factor in three Species of Eurytomidae. Robert E. Bugbee, College of Emporia.

Final Business:

Auditing Committee:

The treasurer's accounts for the period April 1, 1937 to March 31, 1938, have been audited this 2nd day of April, 1938, and found to be in order.

Signed: H. R. Bryson, L. S. Henderson.

Motion made and carried to accept the report of the auditing committee.

Resolutions committee:

The following report was submitted:

Whereas the local committee of the academy has provided not only convenient quarters for the sessions of our society but made special efforts to furnish opportunity for interesting and informative field excursions.

Be it resolved that we extend our appreciation to this committee for their labors in our behalf.

Whereas one of our members, Professor Geo. A. Dean, as retiring president of the Kansas Academy of Science, has devoted considerable time and energy in seeking out and assembling valuable information concerning the Entomological contributions from the State of Kansas and in presenting these facts of historical interest for record in the Proceedings of the Academy,

Be it resolved that the Entomological society express to him its appreciation for this splendid service.

Whereas our society has suffered the loss of Doctor Warren Knaus, president of the society, a faithful charter member whose generous cooperation made possible the establishment and continued publication of the Journal of the Kansas Entomological Society,

Be it resolved that our society express to Mrs. Knaus and other members of his family our deep regret occasioned by his death and our gratitude for this unusual devotion to the society.

Roy F. Fritz
Ralph Voris
H. B. Hungerford, chairman

Motion made and carried to accept as a whole the report of the resolutions committee.

Nominations Committee:

The committee placed in nomination the following members for officers for the year:

For President	L. C. Woodruff
Vice President	R. T. Cotton
Sec. Treas.	H. H. Walkden

R. C. Smith moved that the secretary cast a unanimous vote for these officers. Motion seconded and passed.

It was voted to hold the next annual meeting at Lawrence, Kansas.

Adjournment at 2:30 p. m.

There were 35 members and friends in attendance, from Manhattan, Lawrence, Leavenworth, Fort Scott, in Kansas and from Springfield, Mo., and Fayetteville, Ark.

H. H. WALKDEN, Secretary-Treasurer.

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OF THE
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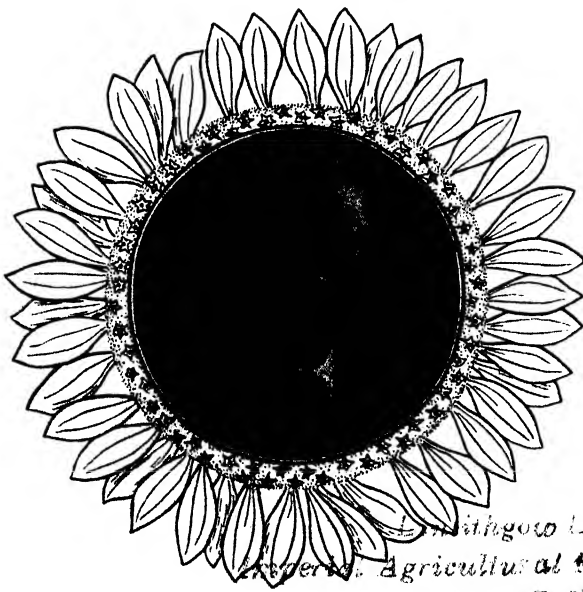


WARREN KNAUS
1858-1937.

Entered as second-class matter December 31, 1927 at the Post-Office at McPherson, Kansas, under the Act of August 24, 1912.

Kansas Entomological Society

Vol. 11, No. 4. October, 1938.

NEW SPECIES OF NORVELLINA (HOMOPTERA, CICADELLIDAE)

DALE R. LINDSAY*

Norvellina bicolorata var. **inflata** n. var.

Closely resembling **N. bicolorata** (Ball) but readily separated by shorter length, extremely inflated front, usually fumate or whitish eyes, and normally immaculate, lemon-yellow elytra anterior to apex of clavus. Fuscous markings decidedly lighter and more sparse. Length 5 to 5.5 mm., width about 1.5 mm.

Vertex inflated, broadly rounding, slightly more produced at center than next eyes; highly arched behind transverse depression. Front bulbously inflated meeting plane of vertex at obtuse angle. Pronotum highly arched to horizontal scutellum.

Color: Vertex pale ivory to whitish, with two median spots of fuscous on anterior margin and a similar spot behind each ocellus; each half of disc posterior to transverse depression centered with a triangle of fuscous vermiculations. Front above matching background of vertex. Pronotum fuscous vermiculate with fumate to white background; the fuscous darker on anterior margin, especially touching eyes, and omitting irregularly patches of light background. Scutellum mostly light brown with white lateral margins except for fuscous spots on the margin posterior to transverse suture. Elytra anterior to apex of clavus usually bright lemon-yellow, sometimes faded to whitish; beyond clavus whitish, nearly hyaline, with fuscous veins and sparse vermiculations, the extreme apical portion solidly fuscous except for hyaline margin and one round spot on tip of third apical cell.

Genitalia: As in **N. bicolorata** (Ball) except for slightly more slender aedeagus, apical beak shorter and less recurved and base not so heavy.

Holotype male, allotype female; White Sands, N. M., June 30, 1932, R. H. Beamer. Numerous paratypes from the following localities: Grand Canyon, Ariz.;

*Contribution from Department of Entomology, University of Kansas

Las Cruces, N. M.; Mojave, Calif.; Tucson, Ariz.; Yucca Grove, Calif.; Jacumba, Calif., Palmdale, Calif.; St. George, Utah; and Las Vegas, Nev. Types and paratypes in the Snow Entomological Collection. Paratypes in collection of Dr. Ball and U. S. N. M.

Norvellina mildredae var. **minuta** n. var.

Closely resembling mildredae in all respects except size and distribution. Small specimens, female 4.75 mm. long and male 4 mm.

Genitalia: Styles and aedeagus shaped as in **mildredae** but about half as large. Pygofer about two-thirds as large as **mildredae.**

Holotype male, allotype female, and one male paratype from Ozona, Tex., July 9, 1936, R. H. Beamer. These miniature **mildredae** are so strikingly smaller than the true species as to warrant varietal ranking. In addition their habitat on the open, arid plains indicates that they are probably from a different host than the montain **Mildredae** taken on red cedar and, according to Ball, found only in sheltered situations.

Norvellina flavida n. sp.

Closely resembling **N. pulchella** (Baker) but easily distinguished by the broadly suffused, canary yellow corium anterior to costal plaque, vertex not so produced and more rounding, with generally lighter markings on disc. Pygofer hook vestigial. Length of female about 5 mm.; male 4.75 mm.

Vertex scarcely produced at center in males, more distinctly in females with definite margin; only slightly arched behind transverse depression. Pronotum slightly arched in lateral view. Elytra long, overlapping.

Color: Front yellow streaked with brown, yellow extending slightly over margin of vertex. Vertex with four brown spots near anterior margin with a similar spot behind transverse depression. Pronotum fuscous, omitting a sprinkling of light areas and irregular, yellowish lateral margins. Scutellum about like pronotum slightly lighter. Elytra with median pattern composed of brown background covered with fuscous vermiculations extending over most of clavus to apex, and spreading laterally to margin at costal plaque, omitting three pairs of small

round semi-hyaline aereoles on mesal margin; elytron distal to clavus with lighter continuation of pattern to apex, mostly in third and fourth apical cells.

Genitalia: Female ultimate segment more than twice length of preceding, rounding posteriorly from lateral margins, slightly produced at center with median notch sinuate either side. Male plates long-triangular, acuminate at apices. Styles longer than usually on distally narrowed portion, rounding on inner margin. Aedeagus in lateral view sharply curved dorsally, tapering on distal half to dorso-ventrally flared apex, about four times broader than shaft next apex; a pair of ventrolateral processes arising at base and tapering to a little past apex of shaft, more curved at tip. Pygofer almost triangular, hook vestigial.

Holotype male, allotype female, 18 miles N. W. Ft. Stockton, Tex., July 11, 1936, R. H. Beamer. Paratypes from following localities: 8 males, 4 females, as above; 4 males, 47 mi. W. Sheffield, Tex., July 10, 1936; 7 males, 16 females, Rodeo, N. Mex., June 8, 1933; 1 male, 1 female, Sheffield, Tex., July 10, 1936; 1 male, 1 female, Las Cruces, N. Mex., July 1, 1932; 1 male and 1 female, Satillo Coahuila, Mex., Nov. 21, 1932; 1 female each from Santa Rita Mts., Ariz., July 17, 1932, and Davis Mts., Tex., June 2, 1937; and 1 male, Hope, N. Mex. Types and paratypes in Snow Entomological Collection. Paratypes in U. S. N. M. and collection of Mrs. J. N. Knull.

Norvellina vermiculata n. sp.

Closely resembling **N. saucia** (Ball) but with median pattern lighter and composed of coarsely reticulate vermiculations over a light background; veins on corium dark and interspersed with light vermiculations. Length about 4.75 mm.

Vertex obtusely angulate in females, distinctly more produced at center than next eyes; males more rounding.

Color: Vertex with four irregular brown spots near anterior margin and one behind each ocellus on ivory to cream-colored background; discs posterior to transverse depression usually vermiculate with brown. Pronotum vermiculate with brown except for light areas along anterior and lateral margins and on disc so that there often appears to be three longitudinal light lines on pronotum. Scutellum tawny to brown omitting numerous light spots. Elytra as above, apices sparsely vermiculate.

Genitalia: Ultimate female segment twice longer than preceding, sloping inward on posterior half of lateral margins; posterior margin truncate with short, slightly bifid, wedge-shaped median tooth, shallowly notched at either side. Male valve obtuse, over half length of preceding segment; plates triangular, about twice as long as basal width, slightly attenuate at apices. Aedeagus in lateral view short, curved dorsally, rounding on outer margin near apex, slightly constricted to apical head bluntly pointed on inner margin; a pair of ventro-lateral processes. Pygofer twice longer than median width, narrowed posteriorly with hook attached on posterior margin, free portion extending dorsally half the length of hook.

Holotype male, allotype female, and four male paratypes, Berger, Idaho, June 15, 1931, Wind vane trap. Other paratypes as follows; two males, Hansen, Idaho, June 22, 1931; five males, Hollister, Idaho, June 22, 1931; two females, Promontory, Utah, Aug. 6, 1930, on Atriplex, G. F. Knowlton, Collector; two males, Murtaugh, Idaho, June 23, 1931; one female each from Wendell, Idaho, June 14, 1934, A tridentata, and Haberman, Idaho, Blue Gulch, Sept. 4, 1932; and one male each from Burley, Idaho, June 23, 1931; Jerome, Idaho, July 8, 1932; Castleford, Idaho, July 11, 1932; and Maybell, Colo., June 30, 1931, R. H. Beamer. Types and paratypes in U. S. N. M. and paratypes in Snow Entomological Collection.

Norvellina varia n. sp.

Closely resembling **N. saucia** (Ball) but with the pronotum more heavily infuscate and the general color pattern more reddish-brown. Length, females about 5 mm., males 4.75 mm.

Vertex distinctly more produced at center than next the eyes, transverse depression usually distinct, posterior disc slightly inclined in lateral view. Pronotum moderately arched in lateral view. Elytra relatively narrow; specimens in dorsal view not appearing as plump as in **saucia.**

Color: Vertex with four elongate, light brown spots near anterior margin with a similar spot behind each ocellus; posterior to transverse depression usually sparsely vermiculate with tawny brown on ivory background.

Pronotum heavily infuscate except for narrow lateral margins and omitting numerous light spots, especially on anterior margin between the eyes. Scutellum with triangular reddish areas on lateral corners, the center more brown and the two colors separted by linear light spots. Elytra with median pattern as in **saucia** but darker, composed of tawny-brown background heavily irrorate with mahogany; distal portion sparsely vermiculate with fuscous over ante-apical cells, more heavily on third and fourth apical cells.

Genitalia: Ultimate female segment about twice length of preceding, posterior margin gently rounding with a very short tooth either side of a shallow median notch, slightly sinuate at either side. Male valve obtuse; plates long-triangular, nearly acuminate on distal half. Aedeagus in lateral view stout, curved dorsally on basal half, distal half nearly straight and ending in bluntly rounded apex; two slender ventrolateral processes arising at base and extending slightly beyond apex, mostly free of shaft. Pygofer broad, sloping distally toward dorsally extended hook arising on posterior margin and with free portion about equal to posterior width of pygofer.

Holotype male, allotype female, Pasadena, Calif., July 31, 1912, E. D. Ball; one male paratype, Pasadena, Calif., April 23, 1908; four paratypes, Ontario Calif., June 14, 1931, E. D. Ball. Types and paratypes in Dr. Ball's collection and paratypes in Snow Entomological Collection. Other specimens are at hand from Three Rivers, Pine Valley, San Jacinto Mts., Campo, San Gabriel Canyon, and Colfax, Calif., and Cisco, Utah, but all showing slight variations and for this reason are not included in the paratypes series. The apparent tendency of this form to vary in shape of and markings on vertex, while genital structures remain constant, accounts for its specific name.

Norvellina numerosa n. sp.

Closely resembling **N. saucia** (Ball) externally, but usually darker on median pattern with lateral margins irregularly bordered with dark fuscous and aedeagus in lateral view, short and thick, more evenly curved and with processes much longer than shaft. Length of female about 5 mm., male 4.75.

Vertex obtusely angulate on anterior margin; in lateral view with shallow transverse depression and posterior disc slightly inclined. Pronotum, in lateral view, scarcely arched. Elytra moderately broad giving specimens stout appearance.

Color: Vertex pale ivory or whitish with four very small brown dots on anterior margin and a similar dot, usually elongate, behind each ocellus; with sparse, sometimes indistinct, vermiculations back of transverse furrow. Pronotum light along lateral margins and in irregular patches on anterior margin, the remainder vermiculate with brown, distinctly or lightly, usually appearing tri-lineate longitudinally with fumose white. Elytra as in **saucia** but darker, usually fringed with irregular fuscous border.

Genitalia: Ultimate female segment twice length of preceding, rounding on posterior margin with a distinct median notch and a smaller notch on either side. Male valve obtuse, plates long-triangular, slightly attenuate. Aedeagus in lateral view much as in **N. varia** n. sp but shorter and thicker, with ventrolateral process extending about one-sixth beyond apex of shaft. Pygofer a little longer than median width with a slender, straight hook broadly attached on posterior margin at an angle of about forty-five degrees with the extended plane of the ventral margin.

Holotype male, allotype female, one male and two female paratypes, Prescott, Ariz., July 29, 1933, R. H. Beamer. Numerous other paratypes from the following localities: Prescott, Yarnell Hts., Yarnell, Superior, Oracle, Tucson, Williams, Granite Dell, Yavapai Co., Congree Jct., and Glenn Oaks, Arizona; San Jacinto Mts., Tehachapi, Orange Co., Laguna Mts., Doyle, Mojave, Chilcoot, Newton, Los Angeles Co., and Fresno, Calif.; Silver City, N. Mex.; Las Vegas, Nina, Alamo, Wells, and Glendale, Nev.; Pintura, St. George, Modena, and Granite, Utah. Types and paratypes in Snow Entomological Collection; additional paratypes in Dr. Ball's collection and in U. S. N. M.

This species and the three preceding species make up a closely related group, which, for convenience, might be called the **saucia** group, since all the above species have at various times been placed in with **N. saucia** (Ball) due to a lack of stable and distinguishing characters.

Only with the use of male genitalia is definite separation possible, since external appearance intergrade promiscuously, sometimes with one combination of characters and sometimes with another, but in the main as described. In selecting types the author chose those specimens possessing the largest number of stable external characters in hopes that the majority of specimens in this group can be thus keyed out. By far the larger number of specimens heretofore classified as **N. saucia** (Ball) belong in this latter species and suggested the specific name.

Norvellina excavata n. sp.

Closely resembling **N. pulchella** (Baker) but with infuscated area on posterior disc of vertex not extending to transverse furrow, the anterior margin of this area with small, rounded excavations each side of median line and conspicuously separated from dots near anterior margin of vertex. Length about 5 mm.

Vertex rounding to front, more produced at center than next the eyes; transverse depression very shallow, disc slightly inclined posteriorly.

Color: Vertex ivory to tan with four very small brown spots on anterior edge of transverse furrow and a slightly elongate spot behind each ocellus; approximately the basal half of vertex with brown to fuscous pattern omitting irregular, small whitish spots; anterior margin of pattern with a small rounded indentation either side of median line. Dorsum of species with typical saddle marking.

Genitalia: Ultimate female segment about twice length of preceding, posterior third of lateral margins rounding posteriorly and nearly straight across on posterior margin, with a slightly bifid, median projection notched on either side about half the length of the projection. Male valve obtuse, plates long-triangular, over twice the length of basal width. Aedeagus in lateral view of medium length, curving dorsally with sharply incurved, bluntly rounding apex; two ventrolateral processes arising near base and extending about five-sixths the length of shaft, the distal one-third somewhat spearheaded, with tips turning slightly outward from shaft. Pygofer narrowing sharply on distal half with a long, stout hook extending dorsally and back at about an angle of thirty degrees with the plane of the ventral margin.

Holotype male, allotype female, Valentine, Tex., July 13, 1927, R. H. Beamer, and paratypes as follows: One male, Ozona, Tex., July 9, 1936, R. H. Beamer; one female, Hildago Co., Tex., July 28, 1928, A. M. James; one female, Davis Mts., Tex., June 2, 1937, D. J. and J. N. Knull; and one male, Uvalde, Tex., Aug. 4, 1937, D. J. and J. N. Knull. Types and paratypes are in the Snow Entomological Collection, and paratypes in the collection of Mrs. J. N. Knull.

Norvellina rostrata n. sp.

Resembling **N. varia** n. sp., but usually a little darker on median pattern, vertex more angulate and produced at center, transverse depression indistinct, and aedeagus in lateral view broad and beak-like in appearance. Length of male 5 mm., female 5.5 mm.

Vertex angulate from dorsal view, in lateral view margin rounded but distinct, with only a suggestion of a transverse furrow and sloping upward from anterior to posterior margin. Pronotum moderately arched in lateral view. Elytra long and narrow.

Color: Vertex mostly brown, omitting whitish to ivory areas along anterior margin and in irregular patches on disc; customary spots along anterior margin modified to more or less indistinct extensions of brown pattern. Pronotum brown on median portion, shading to fuscous on lateral thirds excluding an irregular, light lateral margin and numerous light spots sometimes fused. Scutellum brown to fuscous omitting numerous light spots and a light ivory, triangular spot at each end of transverse suture. Elytra with typical saddle pattern, light margin of basal clavus along claval suture opaque white, basal corium mostly hyaline allowing yellow wall of abdomen to show through distinctly; elytra beyond clavus semihyaline covered with fuscous vermiculations, sparse near clavus but heavier in extremes of third and fourth apical cells, omitting a hyaline area along the median margin in the fourth.

Genitalia: Ultimate segment of female at least twice the length of the preceding segment, rounding strongly on lateral margins; posterior margin strongly produced to a small median notch, sinuate on either side. Male valve obtusely rounding; plates long-triangular, outer margins broadly indented about one-third distance to apices. Aedeagus in lateral view appearing broad

and beak-like, width about one-third of length; width due to a thin, membranous, keel-like extension on outer margin; base thickened dorso-ventrally with a pair of processes arising on outer margin and extending along outer edge of membrane to apex of shaft. Pygofer less than twice length of median width, broadly rounded posteriorly with an irregular hook curved along posterior margin.

Holotype male, allotype female, and two paratypes, male and female, Lucerne, Calif., July 17, 1935, R. H. and Jack Beamer. Types and paratypes are in the Snow Entomological Collection.

Norvellina curvata n. sp.

Resembling **N. pullata** (Ball) but darker and with median pattern extending uniformly from base to apex of clavus and composed of fuscous irrorations and vermiculations. Length of male about 5.25 mm., female about the same length but broader.

Vertex obtusely angulate on anterior margin, in lateral view margin definite, transverse depression shallow, disc inclined posteriorly. Pronotum only slightly arched in lateral view. Scutellum slightly inflated at apex. Elytra of moderate width.

Color: Vertex with whitish to fumose background upon which are four rather large, irregular, light brown spots near anterior margin and a smaller spot behind each ocellus; remainder of disc brown vermiculate over lighter background. Pronotum reticulate with brown or fuscous, omitting a whitish line on each lateral margin and numerous fumose to whitish areas on disc. Scutellum more heavily reticulate, usually with lateral corners and all but extreme apex of apical corner darker and with a roughly triangular light spot at each end of the transverse suture. Elytra with **Norvellina** type median pattern, composed of fuscous irrorations and vermiculations, heaviest on lateral margins and extending to claval suture on clavus; elytra posterior to clavus sparsely vermiculate, heavier in apices of second and third anteapical cells and third and fourth apical cells.

Genitalia: Ultimate female segment round to angulate on lateral-posterior corners, posterior margin truncate with a slight bifid median projection. Male valve obtusely rounding; plates long-triangular, slightly acuminate at tip. Aedeaius in lateral view long, sharply curved dorsally near middle, apex rounding on outer margin to short inward tooth on inner margin; two lateral

processes arising basally and extending very nearly to apex, closely appressed to shaft. Pygofer large, rounding posteriorly on inner margin to a strong hook attached on posterior margin and directed dorsally, free portion as long as posterior width of pygofer.

Holotype male, allotype female, one male and two female paratypes, Grand Teton Nat'l Park, Aug. 18, 1931, R. H. Beamer. Types and paratypes are in the Snow Entomological Collection.

Norvellina glauca n. sp.

Resembling **N. clarivida** (Van D.) but barely tinged with green, with a longer vertex and with spots near anterior margin minute and light brown. Length of male 4.5 mm., female 5.25 mm.

Vertex angulate, posterior margin rounding. considerably more produced at center than next eyes; in lateral view anterior margin rather sharp, transverse depression broad, in female disc nearly concave. Pronotum short, rounding to front, nearly truncate behind. Elytra moderately long.

Color: General color grayish white slightly tinged with green. Vertex whitish to pale ivory with four small light brown spots near anterior margin, sometimes a faint spot behind each ocellus. Pronotum mottled whitish to ivory, occasional faint brown spots on disc, usually behind the eyes. Scutellum about the color of the vertex. Elytra whitish, sprinkled with light brownish to tan vermiculations, obscurely in the Norvellina pattern, slightly more definite on costal and apical margins.

Genitalia: Ultimate female segment about twice length of preceding, gently rounding posteriorly on lateral margins; posterior margin sinuate, produced at center into a long, slightly wedge-shaped projection notched at apex. Male valve roundingly obtuse, plates long-triangular, nearly acuminate apically. Styles on narrowed distal portion short angulate at apex to point on outer margin. Aedeagus in lateral view curving dorsally with inwardly pointing, avicephaliform apex; two broad lateral processes arising at base and extending the length of shaft, apices constricted to inwardly bent point. Pygofer less than twice length of median width, tapering toward a dorsally projecting, fragile hook attached to posterior margin.

Holotype male, allotype female, and two paratypes, male and female, Cuyama Ranch, Calif., July 25, 1935,

R. H. Beamer. Types and paratypes in the Snow Entomological Collection.

A REPORT ON SUPELLA SUPELLECTULIUM (SERVILLE) (ORTHOPTERA, BLATTIDAE)

THOMPSON C. LAWRENCE*

The author observed **Supella supellectulium** (Serville) at Fort Leavenworth, Kansas, in the fall of 1933. These roaches were found in a kitchen and pantry, **Blattella germanica** greatly outnumbering them in the vicinity of the sinks. **S. supellectulium** does not climb glass as well as **B. germanica** but seems to be a more active insect, a better jumper, and, in the males, a better flyer. The Supella's egg sacks are generally attached to sheltered woodwork. Its molted skins, unlike those of its German relative, are often found about its hiding places. It was collected from two houses in Lawrence, Kansas, in 1936.

In the American tropics it is the common household pest, having, no doubt, been introduced from the Old World. It is now worrying exterminators in Atlanta, Georgia, and other southern cities in Texas and Arizona and in the State of Illinois. Probably it is much more widespread than is at present believed, its size and general coloration causing it to be confused with the German roach.

In the summer of 1936 the Fort Leavenworth house from which they were first reported was closed from July tenth to August fifteenth. The outside temperature during this period averaged 82.5 degrees Fahrenheit, the average maximum temperature being 98.17 degrees. The temperature reached 109 twice, and mounted to 112, 111, and 108 successively on the last three days the house was vacant. No roaches at all were then seen until mid-November 1937 when an occasional well-grown **B. germanica** was discovered. A young **Supella supellectulium** was seen during the Christmas holidays. Young German roaches were observed at this time in numbers. This would indicate that no artificial heating devices would be necessary to kill these pests during very hot weather, closure of the building for a more or less extended period being sufficient.

*Contribution from Department of Entomology, University of Kansas.

NEW FORMS AND SUBSPECIES OF NORTH AMERICAN LIBYTHEIDAE AND LYCAENIDAE

WILLIAM D. FIELD, Lawrence, Kansas*

Libythea bachmanii Kirtland

Although the fact is usually not recognized there are two subspecies of **Libythea bachmanii.** The typical subspecies, **Libythea bachmanii bachmanii,** described from a specimen taken in Northern Ohio, ranges from Ontario and New England through the Mississippi Valley south to the Gulf. The description of typical **bachmanii** is given below. Upper surface: The orange brown spot in the cell of the fore wing is separated from the patch of the same color in interspaces Cu^1 and Cu^2 by a narrow brown stripe. Sometimes this stripe is greatly reduced but if this is the case the veins in this region are distinctly lined with brown. That portion of the largest subapical white bar which lies next to the costal margin is narrower than the rest of the bar but does not lie closer to the base of the wing than the remainder of the bar. In the male these white subapical spots are sometimes slightly tinged with red. Under surface: The orange maculation in the fore wing consists of one large orange spot covering the cell and extending outward in interspaces Cu^1 and Cu^2 to within about 5 mm. of the outer margin. The cubital veins are sometimes black but there is never a wide distinct brown or black stripe below the cell. The largest subapical white bar of the upper surface is reproduced on the lower surface.

There are two forms of this subspecies that differ chiefly in the coloration and maculation of the under surface. In one, the apex of the fore wing, the outer borders and the entire hind wing are dark grayish brown with a distinct purplish tinge; there is very little black mottling, and no white mottling except sometimes for a whitish ray in the base of the hind wing along vein Cu^1+M^3. This form is named **kirtlandi** (f. nov.) after the describer of the typical subspecies.

Types.—Holotype, ♂, Lawrence, Kansas, August 1, 1935, collected by R. H. Price; allotype, ♀, same locality and collector, July 27, 1935; paratype no. 1, ♀, same locality, collector and date; paratype no. 2, ♀, Eureka,

*Contribution from the Dept. of Entomology, University of Kansas.

Kansas, Summer, 1934, Fritz Forbes; paratype no. 3 and no. 4, ♀ ♀, same data as paratype no. 2; paratype no. 5, ♀, Leavenworth Co., Kansas, no date, Henry Thomas; paratype no. 6, ♀, Sharon Springs, Wallace Co., Kansas, August 3, 1910. Paratype no. 6 in the Francis Huntington Snow Entomological Collections, University of Kansas. All other types in the author's collection.

The other form of this subspecies is typical **bachmanii.** On the under surface in this form the apex and outer angle of the fore wing are whitish gray heavily mottled with dark brown. Between the anal angle and the apex the marginal border is dark brown. The hind wing is very light gray heavily mottled and reticulated with brown and black tinged with violet or blue. The brown mottling is unusually heavy near the outer margin and across the middle of this wing forming two faint brown bands, one mesial and the other submarginal in position. This dimorphism in the typical subspecies of **bachmannii** (just described) has been noticed by a number of workers but was thought by them to represent merely the normal sexual differences. The form here described as **kirtlandi** was thought to represent the male sex. This form and typical **bachmanii** are found in about equal numbers in both sexes.

The second subspecies of **bachmanii** has been incorrectly referred to by many writers as a dimorphic form. It was described from southwestern Texas (New Braunfels and San Antonio) as a new species under the name of **Libythea larvata** by Herman Strecker.[1] It occurs from Texas through New Mexico and Arizona and south into Mexico. **Libythea bachmanii larvata** differs from **Libythea bachmanii bachmanii** in a number of distinct characters. Upper surface: In the fore wing the brown stripe separating the orange brown spot of the cell from the spot in interspaces Cu^1 and Cu^2 is very distinct and wider than it is in **Libythea bachmanii bachmanii.** In this same wing, that portion of the largest subapical white bar which lies next the costal margin is distinctly narrower than the rest of the bar and is placed nearer the base of the wing than the rest of the bar. The orange patch in the hind wing is somewhat larger than in typical **bachmanii.** Under surface: The cell of the fore wing is

1. Rhop. Het., I, p. 130, 1877.

orange. The light spot between the cell and the inner angle in interspaces Cu^1 and Cu^2 is white (not orange) and sometimes very faintly flushed with yellow. This spot is separated from the orange cell spot by a band of brown which runs from the base of the wing to the brownish black area surrounding the subapical white spots. The white bar between the costal margin and vein M^3 of the upper surface is reproduced on this surface.

The subspecies **larvata** is also dimorphic. The typical form corresponding to the typical form of the subspecies **bachmanii** is even lighter in ground color on the under side of the hind wing and in the apex of the fore wing, being almost white and heavily mottled and reticulated with brown. This brown mottling forms two dark bands across the hind wing, one submarginal in position and the other mesial. There is a partial third band across the base of this wing.

The other form of **Libythea bachmanii larvata** corresponds to the form **kirtlandi** of the typical subspecies. It is lighter in ground color on the upper surfaces being gray (even lighter gray than in **kirtlandi**) with a purplish tinge and only slightly mottled or spotted with black scales. This form is named **streckeri** (f. nov.) after the author of the subspecies.

Types.—Holotype, ♂, Donna, Texas, November 10, 1935, Miss Calla Stainke; allotype, ♀, same locality and collector, November 11, 1935; paratype no. 1 and no. 2. ♂ ♂, same locality and collector, November 10, 1935. All types in the author's collection.

As in the subspecies **bachmanii** this dimorphism is represented in both sexes in about equal numbers.

Libythea carinenta (Cramer)

It was deemed advisable to include a description of this species because of the fact that it is often confused with **bachmanii** and **larvata.** The last two are sometimes placed as subspecies of **carinenta** and indeed, **larvata** has even been placed by one authority as a synonym of **carinenta. Libythea bachmanii** and **Libythea carinenta** are quite distinct species and are easily separated from each other. They differ not only in the form of the male genitalia but also in the shape of the hind wings and in the color pattern. The hind wings of **carinenta** are distinctly projected in the anal region, giving the adults quite

a distinctive appearance. The outer edge of the hind wing is straighter, or more even, than in either **bachmanii** or **larvata.** This is particularly true in the anal region. **Carinenta** differs in the color pattern in many particulars. Upper surface: The white bar between the costal margin and vein M^3 of the fore wing is here greatly reduced in size and distinctly broken, forming two spots. The white spot nearest the costal margin is very small and lies much nearer to the base of the wing, as is the case in **larvata.** The other subapical white spots are also somewhat smaller than in either **bachmanii** or **larvata.** The orange spot in the cell of the fore wing is smaller than in either of the above mentioned forms, occupying only the lower half of the cell next the base of the cubital vein. The orange patch in interspaces Cu^1 and Cu^2 is also much smaller and slightly lengthened toward the innner margin. These two orange spots are separated by a band of brown. This band is even wider than in **larvata.** The orange patch in the hind wing is variable, but it is always smaller than in either **larvata** or **bachmanii.** In some specimens it is present only in interspace M^1. Under surface: The white bar in the fore wing between the costal margin and vein M^3 is distinctly separated into two spots as it is on the upper side. The cell is entirely orange. The light spot in interspaces Cu^1 and Cu^2 is wider than it is on the upper surface and is white in color, or sometimes tinted with yellow. A wide dark brown bar separates this spot from the orange spot of the cell. The hind wings are lighter and more irridescent purplish in color than in **bachmanii** or **larvata.**

Libythea carinenta occurs from Mexico southward to Argentina and Paraguay and probably also occurs as a visitor in the southwestern part of the United State. This is evidenced by one specimen labelled "Texas", which is in the Francis Huntington Snow Entomological Collections.

Strymon melinus franki subsp. nov.

Male.—Under surface: Ground color whiter than in typical **melinus** (the subspecies occuring in the southeastern part of the United States) and lacking the distinct brownish hue. This color would have the position of 19 4-prime f in Ridgeway's "Color Standards", being a cross between pale smoke gray and pale drab-gray and in a few darken specimens between smoke gray and pale

smoke gray. The submarginal row of black bars is usually indistinct, particularly in the hind wings, being much lighter and smaller than in either **melinus** or **humuli** (the subspecies found in New England). The anal and subanal ochraceous-orange or rufous spots are much smaller than in **melinus melinus,** being about the size of those of **humuli.** The orange of the anal spot usually does not extend inward along vein 2nd A to the submesial row of black and white bars. The subanal orange spot does not extend inward as far as the submesial row of black bars or at least it does not fuse with the posterior half of the submesial black and white bar in interspace Cu^1, as is the case in typical **melinus.** The orange from this subanal spot usually only slightly colors the submarginal dark bar in interspace M^3. In most specimens the submesial row of black and white bars is lined on the inner side with a few dark red or orange scales. although this is usually not noticeable except upon careful examination. The chief character by which **franki** can be distinguished from **humuli** and **melinus** is in the irregular shape of this submesial row of bars above vein M^3. The bars of interspaces M^2 and M^1 are placed slightly outward from the rest, the bar in interspace R^1 is placed slightly inward, and the bar in interspace R is placed outward and lies in about the same position as do those of interspaces M^2 and M^1. The black speckled lunular shaped spot between the anal and subanal orange spots is smaller than in **melinus,** gray-blue in color and is rarely lined on its inner side with orange. Although this lunule is about the same size as that of **humuli** it differs from the one found in that subspecies in being light gray blue in color and heavily suffused with black. In **humuli** this spot is dark, about the same tone as the ground color of the wings (mouse gray or deep mouse gray) and with a bluish hue. Body: Like that of **S. melinus melinus** except that there is a little more salmon orange on the posterior part of the abdomen.

Female.—Differs from the male in having the abdomen entirely gray above and in having slightly more of the orange maculation on the wings.

This new subspecies is named for Thomas Frank, an enthusiastic young collector of New York City.

Types.—Holotype, ♂, Lawrence, Kansas, August 9, 1934, W. D. Field; allotype, ♀, same locality and collec-

tor, July 2, 1934; paratype no. 1, ♂, same locality and collector, August 2, 1933; paratype no. 2, ♀, same locality and collector, August 26, 1934; paratype no. 3, ♀, same locality and collector, August 6, 1934; paratypes no. 4 through 28, mixed sexes, same locality and collector, August 10, 1937. Holotype, allotype and paratypes numbers 1 through 10 and numbers 27 and 28 in the author's collection. Paratypes no. 11 and 12 in the Canadian National Collection, Ottawa. Paratypes no. 13 and 14 in the Francis Huntington Snow Collection, University of Kansas, Lawrence. Paratypes numbers 15 through 26 in the collection of F. Martin Brown, Colorado Springs, Colorado.

Note.—In addition to the type series and numerous other specimens of this new subspecies taken in Douglas County, Kansas, the author has examined specimens of typical **S. melinus franki** from the following localities: Kansas—Wallace, Scott, Clark, Pratt, Reno, Harper, Montgomery, Wilson, Crawford, Rawlins, Pottawatomie, Riley and Osborne counties; Oklahoma—Wichita National Forest and Davidson; Texas—Vernon, Sabinal, San Antonio, Castroville, Elmdorf, Ozona, Concan, Sheffield, Romney and Ft. Stockton; New Mexico—Malaga and White City; Colorado—Fountain, Rock Creek and Cascade (all in El Paso County).

Strymon falacer godarti subsp. nov.

Male.—Under surface: Ground color hair brown or chaetura drab as in typical **falacer.** The dark bars of the submesial row of both the fore and hind wing are thinner (about one-half as thick as they are in typical **falacer**) and more widely separated than in **S. falacer falacer.** These bars are outlined on their outer edges by white as is true of typical **falacer.** The bright submarginal markings present in the lower half of the hind wing are orange instead of orange red or red, and are larger and clearer than in typical **falacer.** This subspecies is quite similar to typical **falacer** in other respects.

Female.—Differs from the male in having the bars in the submesial row on the under surface even narrower, in having one or two additional submarginal orange spots on the under side of the hind wing, and sometimes in having two or more faint submarginal orange streaks on this surface of the fore wing.

This subspecies is named after the describer of the typical subspecies.

Types.—Holotype, ♂, and allotype, ♀, Rosement, Teller Co., Colorado, June 20, 1936, Wm. D. Field; paratypes numbers 1, 3, 5, 6, ♂ ♂, same data; paratypes numbers 2 and 4, ♀ ♀, same data; paratype no. 7, ♂, Crystal Creek, Teller Co., Colorado, July 27, 1931, F. M. Brown; paratype no. 8, ♂, Mt. Herman Road, El Paso Co., Colorado, July 6, 1933, F. M. Brown; paratype number 9 ♂, Tiny Town, Colorado, July 17, 1938, C. D. Schryver paratype number 10, ♂, Deckers, Douglas County, Colorado, July 10, 1938, C. D. Schryver. Holotype, allotype and paratype numbers 1, 2, 5, 6 and 10 in the author's collection. Paratype no. 3 and 4 in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Paratypes no. 7 and 8 in the collection of F. Martin Brown, Colorado Springs, Colorado and paratype number 9 in the collection of C. D. Schryver Denver, Colorado.

Note.—Two males taken 7 mi. west of Piedra River, Archuleta Co., Colorado, July 20, 1934, Davenport and Whitmer and three males, Red Creek, El Paso Co., Colorado, June 28, 1937, W. D. Field (all in the collection of F. Martin Brown) are of this subspecies, but were not made part of the type series due to the fact that they are rather worn.

Callipsyche behrii crossi subsp. nov.

Male and female.—Under surface: The ground color is much darker, being more nearly drab and heavily dusted with black and white scales, instead of the smooth light drab of typical **behrii**; this is true particularly of the hind wings. There is a large submesial spot of orange or orange red in interspace Cu^1 of the hind wing and sometimes another, although much smaller one, in interspace M^3. In typical **behrii** only the spot in interspace Cu^1 is present, and it is much smaller and more yellowish than orange in color. The submarginal black spot in interspace Cu^1 of the hind wing and all submarginal black spots in both fore and hind wing are larger and more distinct than in typical **behrii**. The whitish suffusion along the outer margin of the hind wing found in typical **behrii** is here indistinct.

This subspecies is named after F. C. Cross of the Denver Museum of Natural History.

Note.—The author's concepts of typical **behrii** are based upon one hundred specimens of **behrii** from Mammoth in Mono County, California, near the type locality which is Mono Lake, and upon the colored illustration of the male type by Dr. W. J. Holland (The Butterfly Book, plate XXX, figs. 4, 5).

Types.—Holotype, ♂, and allotype, ♀, Nederland, Colorado, July 19, 1936, C. D. Schryver; paratypes numbers 1, 2, 3, ♀♀, same data; paratype no. 4, ♂, and paratype no. 5, ♀, Colorado-Wyoming State Line, July 1, 1936, C. D. Schryver; paratype no. 6, ♀, Troutdale, near Eevergreen, Colorado, July 9, 1936, C. D. Schryver; paratypes numbers 7 and 8, ♀♀, Evergreen Colorado, July 26, 1936, C. D. Schryver; paratypes numbers 9 and 10, ♀♀, Poudre Canyon, Colorado, June 9, 1934; paratype no. 11, ♂, and paratype no. 12, ♀, Platte Canyon, Colorado; paratype no. 13, ♀, Chimney Gulch, near Golden, Colorado, July 5, 1936, F. C. Cross; paratypes numbers 14 and 15, ♀♀, Chimney Gulch, near Golden, Colorado, July 12, 1936, F. C. Cross; paratype no. 16, ♀, Lookout Mountain, near Golden, Colorado, June 21, 1936, R. H. Price; paratype no. 17, ♀, Colorado, F. H. Snow; paratype no. 18, ♂, Estes Park, Colorado, July, 1892, F. H. Snow; paratypes numbers 19, 20, 21, 22, ♀♀, Colorado, collected by Bruce, from the Strecker Collection; paratypes numbers 23 through 36, ♂♂ and ♀♀, Deckers, Douglas County, Colorado, July 10 and July 18, 1938, C. D. Schryver. Holotype, allotype and paratypes numbers 1, 2, 5 through 8, 11, 12, 15, 16 and 23 through 32, 33, and 34 in the author's collection. Paratypes numbers 3, 4, in the collection of C. D. Schryver, Denver, Colorado. Paratypes numbers 9 and 10 in the collection of J. W. Tilden, Santa Cruz, California. Paratypes numbers 13 and 14 in the collection of F. C. Cross, to be deposited by him in the Denver Museum of Natural History. Paratypes numbers 17, 18, 35, 36 in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence. Paratypes numbers, 19, 20, 21, 22 in the Strecker Collection of the Field Museum of Natural History, Chicago, Illinois.

Everes comyntas (Godart)

This species displays seasonal dimorphism. Typical **Everes comyntas** is the form common in the summer. The

females are brown or black brown above with two marginal black spots in the anal region of the hind wings in interspaces M^3 and Cu^1. These black spots are capped above with orange. Underneath they are grayish white in ground color. There is a marginal series of dark points and a submarginal series of dark bars around the outer margins of the wings. The marginal points in interspaces M^3 and Cu^1 of the hind wing are black with suffused rims of metallic green and silver and with orange crescents above. Sometimes there is a little orange above the marginal spot in interspace M^3. There is a submesial series of black spots crossing both pairs of wings, a bent bar at the end of the cell in the fore and hind wings and three black spots across the base of the hind wing. All of these spots are ringed with pure white. The males are similar to the females on the under surface but usually have only two orange crescents in the hind wing. The males are violet blue above with dark brown borders around the outer margins. These borders are usually about one millimeter in width. There is a very faint series of dark points in the marginal border of the hind wing. The point in interspace Cu^1 is darker than the others and may be very faintly outlined on the inner side by orange. Occasionally the same condition obtains in the point in interspace M^3. Underneath the males usually differ slightly from the females in having a little less of the marginal orange in the hind wing, so that while there are usually three of these orange spots on the under surface of the hind wing, the males usually have only two of these.

Everes comyntas f. **meinersi** f. nov.

This is the spring brood of **Everes comyntas,** and it differs quite consistently from the summer broods in a number of characters. The females are slightly darker, being almost black on the upper surfaces. This color is greatly suffused with blue in most specimens; however, this suffusion varies from a few blue scales in the base of the wings to an almost complete suffusion of blue over both pairs of wings. The blue coloration is almost lacking in the apices of the fore wings. There is a complete series of dark dots along the outer margins of the hind wing. The dots in interspaces M^3 and Cu^1 are black and capped with small orange or pinkish crescents. The rest of the marginal dots are surrounded by blue. There is a sub-

marginal series of brownish black bars. Underneath the ground color is lighter than in the summer form and with the maculation much less distinct. This is particularly noticeable in the marginal and submarginal markings of both pairs of wings. There are two instead of three orange crescents in the anal region of the hind wing. The males above are violet-blue with very thin brownish marginal lines. These lines are much less than one millimeter in thickness. In the hind wing the marginal black spots are more distinct than in typical **comyntas.** The marginal black spots in interspaces M^3 and Cu^1 are capped with small but distinct pink crescents. The pink crescent in interspace M^3 is sometimes absent. As in the females the males are paler unneath than in typical **comyntas** and with less distinct marginal markings.

This form is named after Dr. E. P. Meiners of St. Louis, Missouri, the first worker to notice that this species displays seasonal variation (The Dimorphic Blue Female of Everes Comyntas Godt., Ann. Ent. Soc. Am., vol XXIX, pp. 620-621, Dec., 1936). Dr. Meiners, however, thought that this variation was limited to the female sex. The writer has a large series of specimens of both forms from Reading, Pennsylvania; Barberton, Ohio; Aurora, Illinois; Herman, Missouri; Platte City, Missouri; Eureka, Kansas and Lawrence, Kansas. Both sexes very clearly separate into the two forms as decribed above.

Types.—Holotype, ♀, and allotype, ♂, Lawrence, Kansas, April 18, 1936, W. D. Field; paratypes numbers 1 through 34, mixed sexes, same locality and collector, various dates between April 18 and May 3, 1936. One pair of paratypes to be deposited in each of the following museums: Field Museum of Natural History, Chicago, Illinois; U. S. National Museum, Washington, D. C.; American Museum of Natural History, New York City; Los Angeles Museum, Los Angeles; Canadian National Museum, Ottawa; F. H. Snow Entomological Collections, University of Kansas, Lawrence; F. M. Brown Collection, Colorado Springs, Colorado. Holotype allotype and remainder of paratypes in the author's collection.

SOME NEW GRAPTOCORIXA FROM MEXICO AND OTHER NOTES

(CORIXIDAE-HEMIPTERA)

H. B. HUNGERFORD, Lawrence, Kansas*

The genus Graptocorixa was established by me in 1930 for a group of species typified by **Corixa abdominalis** Say. (Pan-Pacific Entomologist, Vol. VII. pp. 22-23). At that time I could see no reason for considering **C. bimaculata** Guerin more than a variety of **Graptocorixa abdominalis** (Say), but believed it to be a variety and not a synonym as treated by Uhler, who was followed by Champion, Van Duzee, and others. Recently I have had the opportunity of studying rather long series of these closely related and confusing forms and find some controlling structural characters that separate them quite readily into specifically different forms. There never has been any difficulty in sorting out typically marked specimens of **G. bimaculata** Guerin with the conspicuous white spots at the tip of the corium, but our perplexity arose when we encountered specimens of **G. bimaculata** (Guerin) with the white spots greatly reduced or specimens of **G. abdominalis** (Say) in which the pale bars at the tip of the corium became confluent, resulting in pale spots. Besides a consistent difference in the shape of the right claspers of the males and in the male palae, these two forms may be distinguished as follows:

A. White spot at distal angle of corium absent or only an irregular pale area. Basal segments of abdominal venter usually reddish. Middle femur of male with a close set row of short pegs on caudoventral margin. Middle femur of female with two or three rows of procumbent pegs on ventral surface .... **G. abdominalis** (Say)

AA. White spot at distal angle of corium nearly always present. Basal segments of abdominal venter not often reddish. Middle femora lacking the rows of pegs described for **G. abdominalis**, ... **G. bimaculata** (Guer.).

Until I came upon the new species **Graptocorixa thomasi** Hungerford (Jl. Kansas Ent. Soc. XI, pp. 28-30,

*Contribution from the Dept. of Entomology, University of Kansas.

1938) with its unique male pala, the slender tapering pala appeared to be one of the strikingly characteristic features of the genus. However, two of the species (**G. robusta** and **G. ruina**) described below either do not belong in Graptocorixa or our generic concept must be modified.

Graptocorixa uhleroidea n. sp.

Size: Length 9.8 to 10.5 mm.; width across head 3 mm. to 3.3. mm.

Color: General color dark above; abdominal dorsum more or less red, the caudal end dark to black. Sternum black; venter of abdomen yellow in females to nearly black in some males; head and legs yellow except basal third of hind femora which are brown. Pronotum crossed by fourteen to sixteen dark bands that are somewhat irregular and incomplete and about as wide as intervening pale lines. The hemelytra crossed by wavy bands the dark ones wider than the light ones except at the base of clavus. At distal end of corium the dark bars usually interrupted or erased to produce a small irregular pale area; the wavy barring of the membrane more or less complete. Basal half of embolium pale; irregular sooty patch at embolial suture, most of embolial margin checkered.

Structural Characteristics: The so-called beak reduced. Frontal depression of male oval, not reaching the eyes and the area in both sexes covered with a dense patch of long silvery hair. Faint median longitudinal carina on pronotum more distinct in anterior portion. Pronotum, clavus and corium rastrate. Front femur roundly, but not greatly, produced at base with tuft of long bristles on anterior face of produced portion in both sexes. In one entire series from Monrovia Canyon, California, 3-2-1930, the males have shed these spines leaving three or four rows of lunate sockets where the bristles stood. Pala long and slender, slightly curved, and ending in stout claw. The male pala with a row of 33 pegs extending from base to tip. Middle and hind legs stout. Strigil of male large, straight on inner margin, rounded on outer margin—about twelve striae, outer ones short. Male genital capsule with right clasper broader on basal half and left clasper more pointed than in **G. uhleri.** Anal lobes of female deeply notched on inner ventral margin.

Location of Types: Holotype, allotype and paratypes in University of Kansas collection. Described from 19 males and 21 females labeled "Monrovia Canyon, California, March 2, 1930, C. H. Martin." In addition we have the following records: "Mission Creek, Santa Barbara, Cal., 1915, C. H. Kennedy." (Cornell Collection); "Alpine, Calif., July 9, 1929, Paul W. Oman"; "Bautista Can., Calif., April 8, 1931, C. H. Martin"; "San Diego Co., Calif., July 4, 1929, L. D. Anderson and P. W. Oman."

Comparative Notes: The name is suggested by the similarity of the male clasper to that of **G. uhleri** Hungerford. The species in other respects is near **G. californica** Hungerford from which it differs by having the base of the anterior femora definitely but not greatly produced at base.

Graptocorixa gentryi n. sp.

Size: Length 7.2 mm. to 7.5 mm.; width of head 2.34 mm. to 2.55 mm.

Color: General color dark; pronotum crossed by nine or ten dark bands about as wide as the pale interspaces; hemelytra crossed by wavy somewhat broken bands, the dark ones on the whole slightly broader than the pale ones, except at the inner base of the clavus; the pattern continuing over the membrane but sometimes separated from the corium by a pale streak. Venter may be light or dark. Head and legs pale except the distal half of the palae, the tibiae and tip of tarsi of middle legs usually dark.

Structural Characteristics: Frontal depression of male broadly oval nearly attaining margin of eye and covered with inconspicuous depressed pile of white hair. Female face rounded. Prothoracic lobes rather elongate and obliquely truncate. Metaxyphus longer than broad. Pala typical of the genus and ending in strong claw, the male pala with row of about 36-38 pegs. Middle tarsus slightly longer than the tibia. Male strigil of moderate size with four striae and genital capsule as shown on Plate.

Location of Types: Holotype, allotype and 7 paratypes in Francis Huntington Snow Collections, University of Kansas. Series labeled "San Bernardo, Rio Mayo, Sonora, Mexico, October 14, 1934, H. S. Gentry."

Comparative Note: This species which is about the size of **G. serrulata** (Uhler) is readily distinguished from it by the narrower post ocular area of the head, by the prothoracic lobe which is broader and more obliquely truncate as well as by the more slender and tapering male pala.

Graptocorixa gentryi devlini n. var.

This form is in nearly every regard like the above species but the right clasper of the male is different. The collection contains three specimens labeled "Cuantha Morelos, Mexico, Oct. 12, 1936, H. D. Thomas" from which the holotype and allotype are chosen and two specimens labeled "El Sabino, Uruapan, Mich., Mexico, July 28, 1936, H. D. Thomas." One of these is a male and its right clasper is identical with that of the type. This may prove to be specifically distinct from **G. gentryi** when longer series are available for study.

Graptocorixa henryi n. sp.

Size: Length 6.3 mm. to 6.6 mm.; width of head 2.16 mm. to 2.25 mm.

Color: Moderately dark, a little lighter and less contrastingly marked than in **G. serrulata** Uhler; the pronotum crossed by eight or nine brown lines usually narrower than the pale interspaces and the last four more or less broken; the dark barring of hemelytra wavy, somewhat interjoined and on the whole very slightly broader than the pale interspaces; head and legs yellowish to light brown; venter of same color, somewhat infuscated.

Structural Characteristics: Frontal depression of male broadly oval and covered with a pile of depressed white hairs. Female face rounded with the white hairs more sparsely covering the area. Interocular space narrow, plainly less than width of eye as measured by projection. Post ocular strip (behind the eyes) of uniform width. Prothoracic lobes rather elongate and rounded at the tip. Metaxyphus distinctly longer than broad. Anterior femur not produced at base; the pala typical of the genus and ending in stout claw; the male with a row of about 32 pegs on pala; the middle tarsus no longer than its tibia. The male strigil circular in outline and consisting of about seven striae. The gential capsule as shown on Plate.

Location of Types: Holotype, allotype and paratypes in Francis Huntington Snow Entomological Collection, University of Kansas. Described from 9 males and 8 females labeled "El Sabino Uruapan, Mich. Mex., Aug. 2, 1936, H. D. Thomas."

Comparative Notes: This species is near **G. melanogaster** Kirk. from which it differs by its smaller size and narrower interocular space; from **G. serrulata** (Uhler) it differs by its more elongate metaxyphus and from **G. gentryi** Hungerford by its rounded prothoracic lobe.

In addition to the above which are typical Graptocorixa, we have the following two, which I assign tentatively to this genus:

Graptocorixa robusta n. sp.

Size: Length 7.74 mm. to 8.4 mm.; width of head 2.9 mm. to 3 mm. A robust species.

Color: General color dark, the dark bands typically black and the pale bands ivory white; the pronotum crossed by twelve or thirteen dark, narrow, somewhat broken, bands that are broader than the pale interspaces; the wavy cross bands of the hemelytra with the dark bands broader except at inner angle of the clavus and near the tip of the corium; on the latter region the dark bands more or less erased leaving an irregular pale area; across the midsection of clavus and corium the black bands three or four times as broad as the pale ones; on the membrane the pale bands broader; base, midsection, and tip of embolium black; venter of thorax black with lighter margins; abdomen brown to blackish; the facial area dark brown, the pigment extending laterally below the eyes to the hypo-ocular septum and dorsally as a median stripe between the eyes; the legs shining, dark brown except basal half of palae which are white, the middle tarsi, the distal half of first segment of the hind tarsus and all of the second which are light brown.

Structural Characteristics: Frontal depression of male rather shallow, covered with depressed pile of fine white hairs; female face not depressed and sparsely covered with fine white hairs. Inter-ocular space narrow, about three-fourths the eye width measured in projection; post ocular strip widest at inner angle of

the eye. Lateral lobe of the prothorax rather elongate and obliquely truncate. Metaxyphus little longer than broad. Anterior femur not produced at base. The pala of male elongate but longitudinally compressed into a thin strip dorsally, bearing beneath its inner margin a row of 15 elongate pegs; the terminal claw moderately stout. The female pala typical for the genus. Middle and hind legs stout. The middle tarsus a little longer than its tibia. The male strigil small. The genital capsule as shown on Plate

Location of Types: Holotype, allotype and paratypes in Francis Huntington Snow Collections. Described from three males and four females labeled "Acapulco, Guerrero, Mexico, July 14, 1937, H. D. Thomas." I have had for several years a teneral male labeled "Arroya S. Marcial, District Alamos, Son. Mexico, October 28, 1934, H. S. Gentry." This shows a rather wide range for this curious Mexican species.

Comparative Notes: This unique species agrees with **G. thomasi** Hungerford in having a relatively long middle tarsus and a male pala that digresses from the generic type. The rastrate surface, the color pattern of the hemelytra, the stout legs and the head characters are typically Graptocorixa.

Graptocorixa ruina n. sp.

Size: Length 10.8 mm.; width of head 3.45 mm.

Color: This teneral specimen cannot be used for any typical color picture. The pronotum is crossed by 15 brown bars, slightly narrower than the intervening pale ones. The wavy barring of the hemelytra indicating the brown bands slightly broader. The distal angle of the clavus with one brown bar erased.

Structural Characters: Male facial depression shallow, covered sparsely with a pile of fine white hairs. Prothoracic lobe unusually broad, the rear margin shorter than the distal and rounding into it. Metaxyphus a little longer than broad. The anterior femur of the male ventrally produced beyond its middle on the front face of which is an oblqiue, compact row of seven long bristles; the pala in this shriveled specimen is somewhat warped, but the arrangement of the row of pegs which curves back upon itself at the base is character-

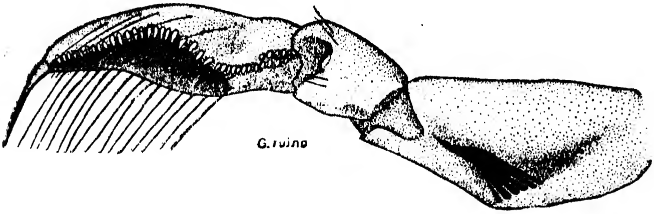
istic. The middle femur is thickened on its distal half, the beginning of the thickened portion marked by a row of conspicuous long hairs. Middle tarsus distinctly longer than its tibia. The caudoventral margin of hind femur with a row of 18 pegs, their size increasing to the distal end of the row. The male strigil with four striae and protected on its right side by the strongly sclerotized overlapping fold of a connexival lobe. The anal lobes asymmetrical, the right one smaller with a thickened tuft of hairs on its inner margin and the left lobe with two hooklike flaps extended from its inner dorsal margin and a notch in its inner ventral margin. The genital capsule collapsed in this specimen, the right clasper now appearing as shown on Plate.

Location of Type: Holotype in Francis Huntington Snow Collections and labeled "Arroyo Marcial, District Alamost, Son. Mexico, Oct. 28, 1934, H. S. Gentry." This specimen taken same date and place as the specimen of **G. robusta** Hungerford.

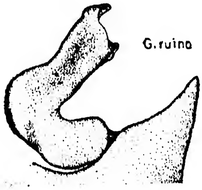
Comparative Note: The shape of the front femur of the male is like that of **G. thomasi** Hungerford and the modifications of the anal lobes and the shielded strigil also show a relationship to **G. thomasi** Hungerford.

Explanation of Plate.

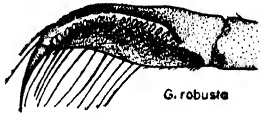
1. **Graptocorixa ruina** new species. Front leg of male.
2. **Graptocorixa ruina** new species. Right clasper.
3. **Graptocorixa robusta** new species. Male pala.
4. **Graptocorixa devlini** new species Male genital capsule.
5. **Graptocorixa gentryi** new species. Male genital capesule.
6. **Graptocorixa henryi** new species Male genital capsule.
7. **Graptocorixa robusta** new species Male gentital capsule.
8. **Graptocorixa uhleroidea** new species. Male genital capsule.



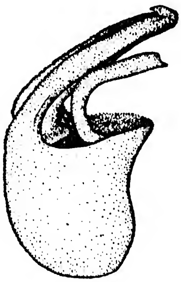
G. ruina



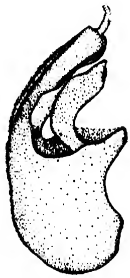
G. ruina



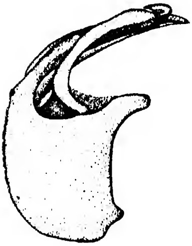
G. robusta



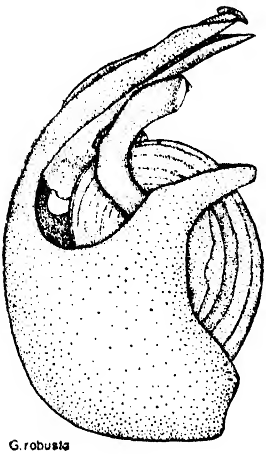
G. gentryi



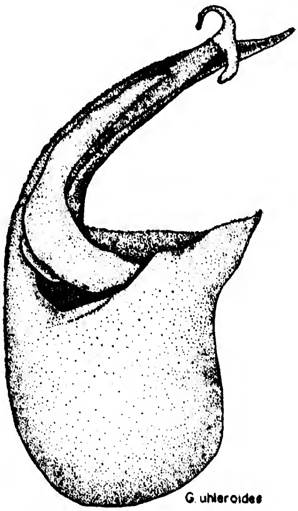
G. henryi



G. devlini



G. robusta



G. uhleroides

A CICADA AS A COTTON PEST (1)

DWIGHT ISELY, University of Arkansas

Cicadas are best known for their periodic occurrence and for their song. They are not ordinarily considered as insects injurious to crops. The principle exception is the periodical cicada which may cause damage to fruit trees by oviposition punctures in the twigs and smaller branches. This damage is of importance because of the enormous numbers which may occur and not because of any peculiarity in habit of this species. Injury caused depositing eggs in the stems of corn and cotton was described by Newell (2) in 1905. In Newell's paper the species was designated as **Cicada erratica** Osborn but this name has since been listed as a synonym of **Diprocta vitripennis** Say (3). During 1937 severe local damage to cotton by this species occurred in the river bottoms of at least nine counties of Arkansas. This injury was also caused by oviposition punctures, as has been the case previously reported.

The eggs of **vitripennis** were deposited in the stems of young plants, in the branches of older ones and occasionally in leaf petioles. Above the point of puncture the plants usually died. Growth of many plants started again below the point of the locust egg puncture, resulting in low bushy plants. These plants were later in coming into production but since the latter part of the season of 1937 was favorable to cotton, much of the loss expected in July was recovered.

As stated the injury was local, although severe in spots. As an extreme example, on one plantation of about 450 acres in Lee County in the St. Francis river bottoms, the cotton was killed outright or so severely injured that it was plowed up on about 15 acres. On an additional 30 acres an average of 50 per cent of the plants were injured. Much of the injury on these 30 acres was outgrown later in the season. In addition, there was some scattered injury. The damage on this plantation was the most severe observed. It is doubtful if 500 acres were

(1) Research Paper No. 617, Journal Series, University of Arkansas.

(2) Newell, Wilmon, 1906. Notes on a little known insect enemy of cotton and corn. U. S. D. A. Bur. Ent. Bul. 60, 52-58 p.

(3) Davis, W. T. 1928. Cicadas belonging to the genus Diptrocta. . Jour. N. Y. Ent. Soc. 36: 439-456.

injured in this county. Reports and specimens from nine counties indicated that local injury was scattered over the bottomlands of the eastern part of the state. One report was from the southwestern part.

This cicada is apparently not dependent on tree hosts for the development of its immature stages. On one plantation the nymphs had emerged from the soil in cotton fields that had been in cultivation since some time before the Civil War. There was a relationship between an abundance of cicadas, however, and trees or woody plants in the vicinity. All of the spots of injury observed were in bottomlands and in the vicinity of trees with a thick undergrowth of brush, although not necessarily adjacent to it. The cicadas remained in this cover during the night and cooler parts of the day. They began to fly from cover after eight o'clock in the morning, and activity in flying, oviposition and singing increased with the increase in temperature. The activity was greatest during the heat of the day. The season of activity was about a month, beginning the second week in June. It attracted most attention during the last week of June.

While more of the oviposition appeared to be in cotton than in any other plants, on terminals of trees and other plants dead foliage presented obvious evidence of injury. The woody plants preferred for oviposition in order of importance appeared to be as follows: soft maple, willow, honey locust, black locust, **Amorpha** sp., pecan, hackberry, and trumpet vine. Of the herbaceous hosts, morning glory was next in importance to cotton. The number of eggs in a single series of punctures varied from 16 to 49.

The heavy infestation of **D. vitripennis** in 1937 may have been favored by the lateness of cotton in the bottoms. An early spring flood had delayed cotton planting and the usual early cultivation. Had the cotton been plowed and hoed earlier, it is probable that many of the nearly mature nymphs near the surface of the soil would have been destroyed. Since many of the cicadas emerged from the soil in the cotton fields, this points to a possible means of repression.

A NEW METHOD OF FEEDING ADULT HORN FLIES, HAEMATOBIA IRRITANS L., AND STABLE FLIES, STOMOXYS CALCITRANS L.

W. G. BRUCE and CRAIG EAGLESON,

U. S. Deparment of Agriculture,
Bureu of Entomology and Plant Quarantine,
Division of Insects Affecting Man and Animals

The artificial feeding of horn flies, **Haematobia irritans** (L.), and stable flies, **Stomoxys calcitrans** (L.), has often been accompanied by considerable time-consuming labor and no little dissatisfaction. This is especially true where small animals are used as the source of blood supply. By providing blood in glass tubes and by utilizing the insects' positive phototropism, a rapid, inexpensive, and satisfactory method of feeding these two species of blood-sucking flies has been developed.

For maintaining the flies, a cage (fig. 1) 6 inches deep, 12 inches wide, and 16 inches long has been found to be satisfactory. The sides of the cage (fig. 1, A) are made of ¾-inch lumber, the bottom of 26-gauge galvanized sheet iron, and the top (fig. 1, B) of 18-mesh galvanized wire screen. A sliding door (fig. 1, C) 5 by 5 inches in one side permits access to the interior of the cage. Approximately 500 horn flies or 250 stable flies can be conveniently handled in a cage of this size. A galvanized sheet-iron cover (fig. 1, D) 8 by 12 inches fits over one-half of the cage. Soldered to the cover about 1 inch from the end is a feeding-tube rack (fig. 1, E) made of 26-gauge galvanized sheet iron 3 inches wide, 3 inches high, and 9 inches long, in which six equidistant holes one-half inch in diameter are bored. Immediately below the feeding-tube rack is an opening in the cover three-fourths inch wide and 7 inches long. This opening admits light into the cage and provides a place for the feeding tubes to come in contact with the screen. Six glass tubes (fig. 1, G), 6 to 8 mm in inside diameter, 10 cm long. and fitted on one end with a medicine-dropper bulb (fig. 1, H), are placed in a vertical position through the holes in the feeding-tube rack and in contact with the screen of the cage.

Three tubes of blood at a temperature of 25 degree to 40 degrees C. and three tubes of water are ample for one feeding. Horn flies seem to feed best on defibrinated bovine blood. Stable flies feed on defibrinated

blood, and also thrive on acidulated bovine or swine blood. Two feedings per day are sufficient.

Horn flies thrive best in an environment of high humidity. A wet cloth or towel placed over the uncovered half of the cage will supply the necessary moisture. Stable flies are less sensitive to adverse conditions than are horn flies. They do not require as high humidity, though water for drinking must be constantly available. The wet cloth and metal cover occlude light from the cage except that which enters through the slot in the cover. The unfed flies will congregate on the screen under this slot and will readily find the food supply. As the flies become engorged they move away from the light, allowing other flies to feed. It is well to add that fresh air is essential to the life of caged horn flies and that tobacco smoke is lethal.

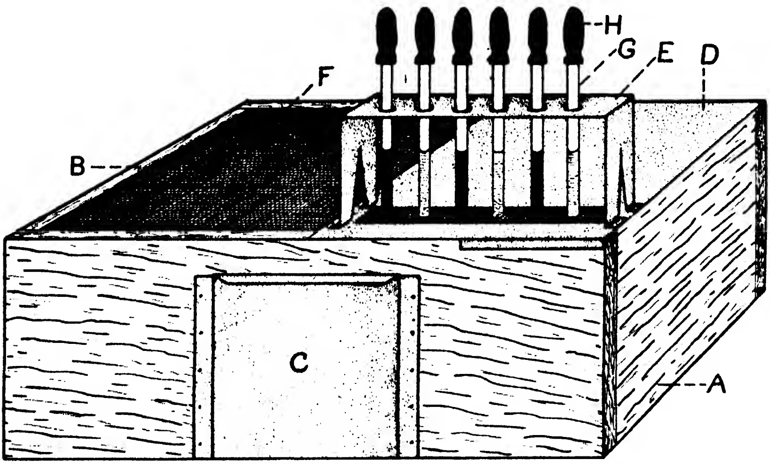


Fig. 1.—Cage for horn flies and stable flies. A, Cage. B, 18-mash galvanized wire screen. C, Sliding door. D, Galvanized sheet-iron cover. E, Feeding-tube rack. F, Uncovered half of cage. G, Glass tube. H, Rubber bulb.

ELMIS COLUMBIENSIS ANGELL A SYNONYM OF ZAITZEVIA PARVULUS (HORN)* 1

MILTON W. SANDERSON,
Department of Entomology, University of Arkansas.

Zaitzevia parvulus (Horn)

Macronychus parvula Horn, Trans. Am. Ent. Soc., III: p. 41, 1870.

Elmis columbiensis Angell, Ent. News, III: p. 84, 1892.

At the time of its description, Horn assigned **parvulus** to the genus Macronychus supposedly by the presence of seven antennal segments. However, the actual presence of eight segments places it with Zaitzevia Champion. In 1892, **Elmis columbiensis** Angell was described from Fraser River Valley, British Columbia. Apparently Angell did not designate types of this species, but specimens collected at type locality and determined as such by Angell have been found in the collections of the late Mr. Warren Knaus, McPherson, Kansas, and the Henry Ulke Collection at Pittsburgh, Pa. A study of the type of **Zaitzevia parvulus** (Horn), described from California, and the specimen of **Elmis columbiensis** Angell from the Knaus collection convinces me that they are identical.

* Research Paper No. 500, Journal Series, University of Arkansas.
1 Coleoptera: Dryopidae.

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